ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

CHM056A
March 2015

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INTRODUCTION

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CHAPTER 1
INTRODUCTION

STUDY GOALS AND OBJECTIVES

The goal of this study is to help readers achieve a comprehensive understanding of the recent technological advances, trends and market opportunities in elastomer manufacturing, applications and global markets. This report will cover global markets for both thermoplastic elastomers (TPE) and thermoset elastomers (TSE).

Thermoset elastomers (i.e., rubbers) include natural rubber (NR) and synthetic rubbers. Synthetic rubbers include synthetic polyisoprene rubber (IR), polybutadiene rubber (BR), styrene-butadiene rubber (copolymer of polystyrene and polybutadiene [SBR]), nitrile rubber (copolymer of polybutadiene and acrylonitrile, NBR), chloroprene rubber (CR), isobutylene isoprene rubber (IIR), ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM). NR, IR, BR, SBR, NBR and CR are unsaturated rubbers. IIR, EPM and EPDM are saturated rubbers. Other saturated rubbers with relatively small volumes include epichlorohydrin rubber (ECO), polyacrylic rubber (ACM, ABR), silicone rubber, fluorosilicone rubber (FVMQ), fluoroelastomers (FKM and FEPM) and chlorosulfonated polyethylene (CSM).

Thermoplastic elastomers include thermoplastic styrenic (TPS), thermoplastic polyolefin (TPO), thermoplastic polyester elastomer (TPEE) and thermoplastic polyurethanes (TPU). Other TPEs with relatively small volumes of consumption include thermoplastic vulcanizate (TPV), thermoplastic polyamides (TPA), polyvinyl chloride-based thermoplastic elastomer (TPVC) and melt processable rubber (MPR). TPS, also known as styrene block copolymer (SBC), is the largest product in terms of volume. SBC includes styrene butadiene styrene (SBS), styrene isoprene styrene (SIS), styrene ethylene butylene styrene (SEBS) and styrene ethylene propylene styrene (SEPS).

This report will describe the major types and advanced technologies of elastomers manufacturing processes. Key properties and advanced technologies related to raw materials will be discussed, as well as the commercial applications in which these materials are used. Present consumption and future demand for these materials will be measured and forecasted for global markets categorized by four world regions: North America, Europe, China, Rest of Asia and Rest of the World.

Trends in technology will be analyzed and forecast. The impact of governmental regulations will be ascertained. Patents of elastomers will be reviewed. The structural dynamics of the industry will be outlined, along with profiles of key manufacturers in the U.S., China, Germany, Japan, Korea, India, France, and other countries.

This report will review, measure and forecast global markets for elastomers and will forecast trends of production and sales in these markets through 2019. Important manufacturers, technologies and factors influencing demand will be discussed.

BCC Research’s goal in conducting this study was to determine the current status of the global elastomer industry and to assess its growth potential over a five-year period from

2014 to 2019. A primary objective was to present a comprehensive analysis of the current elastomer market and project its future direction.

REASONS FOR DOING THE STUDY

There are three reasons for doing this study:

- Elastomers manufacturers and suppliers must understand market trends and new technologies in the industry to plan their production and research and development (R&D) for the next few years and beyond.
- Resins and raw materials suppliers must understand the market trends and technological requirements from elastomers.
- Elastomer users such as tires companies must understand the trends of technologies and markets to make the best raw materials choices and to improve their products in the future.

SCOPE OF REPORT

The report forecasts the size of the global market in current U.S. dollars for elastomers in value terms and/or volume terms for each material from 2013 through 2019. The forecasts are classified on the basis of product type, technology type, end application and geographical region.

An elastomer is an elastic polymer that usually has high viscosity and weak inter-molecular forces. It can be thermoplastic or thermoset. This report covers both types.

INTENDED AUDIENCE

The intended audience of this report includes resin suppliers and elastomer manufacturers. Elastomer consumers from the electronic or electrical, tire, automotive, medical and other industries may also be interested in this report.

METHODOLOGY

Both primary and secondary research methodologies were used to prepare this study. Estimates of current market demand are made for 2013 and 2014 and are projected over the next five years through 2019. Projections are made in terms of constant U.S. dollars (2014), unadjusted for inflation. Growth is presented in terms of a compound average annual growth rate (CAGR).

INFORMATION SOURCES

Information sources for this report include experts, executives, professors, officials, financial reports and papers from resin companies, elastomers manufacturers, industrial associations, universities and governmental departments. They include DuPont, Dow Chemical, LG Chemical, Styron, Sinopec, Tsinghua University, Ministry of Commerce of

China and the National Bureau of Statistics of China. Information sources for the study also include online research, patent literature, technical journals, trade magazines, governmental data and conference papers from China, Germany, France, Japan, South Korea, and the U.S.

ANALYST'S CREDENTIALS

Jason Chen has been an analyst and consultant for the composite, fiber, textile and energy industries for a decade. He is a regular writer and contributing editor for *Composites Manufacturing* (American Composites Manufacturers Association), *International Fiber Journal*, *Filtration News*, *Platts Emission Daily*, *Vision Systems Design* and *MobileTex*. He has authored the books *Asian Automotive Textiles: Opportunities and Challenges for Leading Producers* and *China's Chemical Fiber Producers*. He is also the author of BCC Research market research reports *Tire Reinforcement Materials: Technologies and Global Markets* (AVM077B), *Global Markets for Polyolefin Resins* (PLS052A), *Global Markets for Non-Polyolefin Commodity Resins* (PLS067A) and *The Chinese Market for Medical Polymers* (PLS074A).

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Chapter 2

SUMMARY

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 2
SUMMARY

This report breaks the global elastomer market into two major markets: thermoplastic elastomers (TPE) and thermoset elastomers (TSE).

TSEs, also known as *rubbers*, include natural rubber (NR) and synthetic rubber. Synthetic rubbers include IR, BR, SBR, NBR, CR, IIR, EPM and EPDM. NR, IR, BR, SBR, NBR and CR are unsaturated rubbers. IIR, EPM and EPDM are saturated rubbers. Other saturated rubbers with relatively small volumes include ECO, polyacrylic rubber (e.g., ACM, ABR), silicone rubber, fluorosilicone rubber (FVMQ), fluoroelastomers (e.g., FKM, FEPM) and CSM.

TPEs include thermoplastic styrenic (TPS), TPO, TPV, TPEE and TPU. Other TPEs with relatively small volumes of consumption include TPA, TPVC and MPR. TPS, also known as styrene block copolymer (SBC), is the largest product in terms of volume. SBC includes SBS, SIS, SEBS and SEPS.

Estimates and forecasts of the global elastomer markets from 2013 through 2019 are provided in the following table:

SUMMARY TABLE

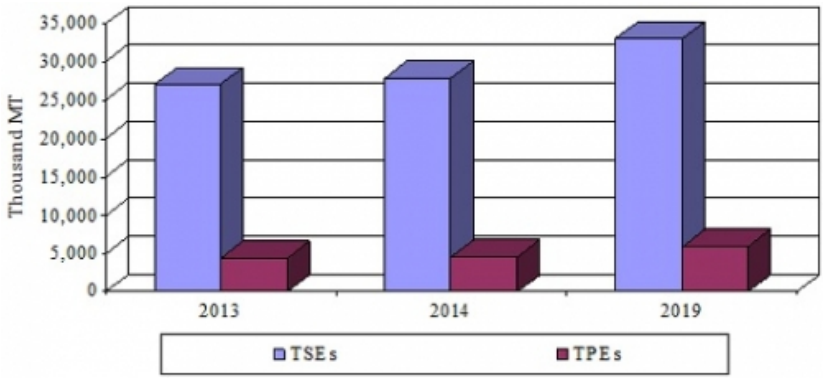
GLOBAL ELASTOMER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014-2019
TSEs	26,999.2	27,938.4	33,014.2	3.4
TPEs	4,397.8	4,588.5	5,950.7	5.3
Total	31,397.0	32,526.9	38,964.9	3.7

Source: BCC Research

SUMMARY FIGURE

GLOBAL ELASTOMER MARKET BY PRODUCT, 2013-2019 (THOUSAND METRIC TONS)



Source: BCC Research

The global elastomer market will grow at a moderate CAGR of 3.7% from 2014 through 2019. Some segments in the industry will take off and enjoy rapid growth through 2019, whereas others will dwindle in the next few years. For example, the Chinese thermoplastic elastomer market will grow at a high CAGR of 8.6%, whereas thermoset elastomers in North America will experience a CAGR as low as 0.8%. Details of these markets will be discussed in the following chapters.

Chapter 3

OVERVIEW

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 3
OVERVIEW

ELASTOMER MARKET DEFINITION

An elastomer is a polymer with viscosity and elasticity along with weak inter-molecular forces. It includes both thermoplastic elastomers (TPEs) and thermoset elastomers (TSEs).

Thermoset elastomers, also known as rubbers, include natural rubber (NR) and synthetic rubbers (SRs). Synthetic rubbers include synthetic polyisoprene rubber (IR), polybutadiene rubber (BR), styrene-butadiene rubber (copolymer of polystyrene and polybutadiene, SBR), nitrile rubber (copolymer of polybutadiene and acrylonitrile [NBR]), chloroprene rubber (CR), isobutylene isoprene rubber (IIR), ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM). NR, IR, BR, SBR, NBR and CR are unsaturated rubbers. IIR, EPM and EPDM are saturated rubbers. Other saturated rubbers with relatively small volumes include epichlorohydrin rubber (ECO), polyacrylic rubber (ACM, ABR), silicone rubber, fluorosilicone rubber (FVMQ), fluoroelastomers (FKM and FEPM) and chlorosulfonated polyethylene (CSM).

Thermoplastic elastomers include thermoplastic styrenic (TPS), thermoplastic polyolefin (TPO), thermoplastic polyester elastomer (TPEE) and thermoplastic polyurethanes (TPU). Other TPEs with relatively small volume of consumption include thermoplastic vulcanizate (TPV), thermoplastic polyamides (TPA), polyvinyl chloride-based thermoplastic elastomer (TPVC) and melt processable rubber (MPR). TPS, also known as styrene block copolymer (SBC), is the largest product in terms of volume. SBC includes styrene butadiene styrene (SBS), styrene isoprene styrene (SIS), styrene ethylene butylene styrene (SEBS) and styrene ethylene propylene styrene (SEPS).

SIGNIFICANT TRENDS

Significant trends that will affect growth in the elastomer market include weight reduction, strength improvement, noise reduction, cost-performance improvement and recyclable ability.

- *Weight reduction:* Lighter tire or automotive elastomers will replace standard products. Elastomer producers will reduce product weight by employing new materials or improving elastomer construction. Lightweight materials offer the potential to design lighter tires that reduce rolling resistance and carbon dioxide emissions, as well as improve fuel efficiency.

- *Energy saving:* In tire application, tread rubber, bead filler and inner liner could account for 39%, 13% and 8% of the oil consumption of a tire, respectfully. Elastomer manufacturers are developing new elastomer varieties to help tire producers reduce energy consumption.

- *Recyclability improvement:* Stricter environmental laws and new governmental goals will require elastomer producers to manufacture more recyclable tires and other elastomer products. Thermoplastic elastomers,

which serve as more recyclable replacements to thermoset elastomers, will gain a strong momentum on this.

INTERNATIONAL TARGETS AND REGULATIONS

CARBON DIOXIDE EMISSION REDUCTION

To address the issue of global climate change, developed countries reached an agreement in 1997 called the Kyoto Protocol, promising to cut their emissions of carbon dioxide, the main greenhouse gas, by 5.2% by 2012.

Carbon dioxide reduction continued after 2012. An agreement was reached to extend the Kyoto Protocol during a plenary session at the United Nations Climate Change Conference (COP17) in Durban on December 11, 2011, and details were discussed further in subsequent international climate change talks. The carbon reduction target will force tire manufacturers to reduce carbon dioxide emissions through efforts such as improving energy efficiency and recycling gas emissions. This trend will provide a strong momentum to push elastomers to develop new elastomers products for greenhouse gases reduction.

Some countries have proposed emission reduction targets for the post-2012 period. The proposed targets change frequently due to factors such as the fluctuation of the economic environment and shifts in government, but long-term emission reduction is still foreseeable.

- The European Union (E.U.) may cut carbon dioxide emissions by 25% by 2020 from 1990 levels and cut 80% by 2050 from 1990 levels.
- The U.S. retreated from the Kyoto Protocol in 2001 and does not have a carbon dioxide emission reduction target, but the Barack Obama Administration has suggested a carbon dioxide reduction target of 17% to 20% by 2020 from 2005 levels.
- The Chinese government has promised to reduce the country’s carbon intensity (carbon dioxide emissions per 10,000 renminbi [RMB], the official currency of the People’s Republic of China) of gross domestic product (GDP) by 40% to 45% by 2020 from 2005 levels. China may cap the total volume of carbon dioxide emissions after 2020. This target may result in a carbon trading system from which polyolefin manufacturers may be compensated for their efforts to reduce carbon dioxide emissions.
- The Japanese government had promised to cut carbon dioxide emissions by 25% by 2020 from 1990 levels. This intent has been denied by the current government, but it is still insisted upon by some political parties.

Transportation is one of the world’s largest greenhouse gas emission segments and produces nearly one-quarter of the world’s emissions of carbon dioxide. Governments have developed plans to reduce carbon dioxide emissions from transportation to meet reduction goals. The E.U. will limit the average carbon dioxide emission from a new

passenger car to 120 grams per kilometer, down 25% from the 2006 level of 160 grams per kilometer. It has also proposed to reduce the carbon dioxide emission to 70 grams per kilometer by 2025 and to an even lower level beyond that time. In China, according to the 12th Five-Year (2011 to 2015) Plan for the Automobile Industry, the carbon dioxide emission of a new car will decrease by 30% by 2015 from 2010 levels.

The carbon dioxide emission regulations will force tire manufacturers and automakers to employ lighter or stronger elastomers for reducing tire and automobile weight and rolling resistance. If a passenger car tire can reduce its rolling resistance by 20%, its carbon dioxide emission will decrease by 4 grams per kilometer to five grams per kilometer of driving. Tire and automotive applications account for nearly 60% of global elastomers consumption, so advanced lightweight or high-strength elastomers will have the potential to gain more market shares in the future.

GLOBAL TARIFFS

Global tariffs have been raised for global tire trade. The U.S., Argentina, Brazil and Russia have protected their tire industries by increasing the tariffs for imported tires in the last few years. The tariffs will inhibit the growth of tire exports and elastomers consumption in tire manufacturing countries, especially China.

Global tariffs for elastomers also distort the growth of elastomers. The Chinese government puts a significant deference between taxes on natural rubber and the so-called *compounded* rubber, which increases the unnecessary production of a large volume of compounded rubber for the sole purpose of reducing import taxes.

RECYCLING

Many countries have established laws or regulations for recycling tires due to rising environmental and resource constraints. Most U.S. states have their own laws or regulations regarding scrap tire recycling. In July 2004, the New York State Department of Environmental Conservation (NYSDEC) released the Waste Tire Management and Recycling Act of 2003 to reduce the stockpiles of its 18 million to 20 million waste tires generated each year. This law levies a tax of an average of $2.50 per new tire for managing and recycling waste tires. These laws may force the tire industry to employ more recyclable materials to reduce recycling costs.

Raw material shortage will force manufacturers to produce more recyclable products as well. China largely increased production of recycled rubber in recent years. Today, China alone maintains more than 85% of global production of recycled rubber.

TIRE LABELING

Tire labeling is a new regulation that took effect in Europe in July 2010. Tires for cars, vans and trucks produced after July 2010 must be labeled for wet grip, rolling resistance and noise performance. The regulation aims to reduce carbon dioxide emissions and rolling

resistance, as well as to improve tire performance. This regulation will boost the application of lightweight or noise-reduction elastomers.

REGISTRATION, EVALUATION, AUTHORIZATION AND RESTRICTION OF CHEMICALS

Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) is the European Community's regulation on chemicals and their safe use. According to REACH, a manufacturer should manage the risks from chemicals and provide safety information on the substances. REACH aims to improve the protection of the environment and human health, but registration and evaluation also increase the costs for tire and elastomer producers.

Chapter 4

GLOBAL ELASTOMER MARKET BY PRODUCT AND APPLICATION

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CHAPTER 4
GLOBAL ELASTOMER MARKET BY PRODUCT AND APPLICATION

The chapter describes the global elastomer market by products and applications. Trends in technological advances will be briefly discussed.

This chapter breaks the market down to segments at different levels:

- The global elastomers market is broken down into two major segment: thermoplastic elastomers (TPEs) and thermoset elastomers (TSEs). Thermoset elastomers are elastomers that irreversibly cure. Thermoplastic elastomers are pliable or moldable above specific temperatures and return to solid state upon cooling.

- The TSE segment is further divided to three sub-segments: natural rubber (NR), synthetic rubbers (SRs) and recycled rubbers (RRs). Recycled rubber is also known as *reclaimed* rubber.

- The Synthetic Rubber sub-segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, EPR and Others. The EPR section includes EPM and EPDM. The Others section is comprised mostly of saturated rubbers with relatively small volumes, including ethylene acrylate (AEM), fluoroelastomers (FKM), epichlorohydrin rubber (ECO), silicone rubber (e.g., fluorosilicone [FVMQ]), acrylic elastomer (ACM) and chlorosulfonated polyethylene (CSM).

- The TPE segment is further divided to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs with relatively small volumes of consumption, including TPA, TPVC and MPR.

- A TSE or TPE product may be further broken down into sections by sub-products.

Most segments, sub-segments and sections will be further divided or described by regions and applications. Capacities, technologies, industry trends and leading players will be also discussed.

The following table is a repeat of the previous Summary Table. It includes the estimates and forecasts of the two major markets: TSEs and TPEs.

TABLE 1

GLOBAL ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
Thermoset	26,999.2	27,938.4	33,014.2	3.4
Thermoplastic	4,397.8	4,588.5	5,950.7	5.3
Total	31,397.0	32,526.9	38,964.9	3.7

Source: BCC Research

Global TSE consumption will have stable growth in the next few years, but TPEs will experience stronger growth.

ELASTOMER APPLICATIONS

Approximately 60% of the world’s elastomers are used in automobiles and cycles. Market estimates and forecasts are detailed in the following table.

TABLE 2

GLOBAL ELASTOMER MARKET BY APPLICATION, THROUGH 2019
(MILLION UNITS)

Application	2013	2014	2019	CAGR% 2014–2019
Automobiles and cycles	18,325.8	19,188.9	23,120.5	3.8
Others	13,071.2	13,338.0	15,844.4	3.5
Total	31,397.0	32,526.9	38,964.9	3.7

Source: BCC Research

TIRES AND AUTOMOTIVE ELASTOMER APPLICATIONS

Most automobile and cycle elastomers are used for making tires. Others are used for making automotive components such as sealing strings, sealing pads, O rings, covers, interiors and hoses.

TABLE 3

GLOBAL AUTOMOBILE ELASTOMER MARKET BY APPLICATION, THROUGH 2019 (MILLION UNITS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	16,444.8	17,251.3	20,709.1	3.7
Automotive	1,881.0	1,937.6	2,411.4	4.5
Total	18,325.8	19,188.9	23,120.5	3.8

Source: BCC Research

Tire Elastomers

Most tire elastomers are used in radial light-duty tires. Radial heavy-duty tires also have big market shares. Cycle tires, including those for bicycles and motorcycles, hold a small share. Details are provided in the following table.

TABLE 4

GLOBAL TIRE ELASTOMER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Radial light duty	8,218.6	8,532.2	9,959.7	3.1
Radial heavy duty	5,770.0	6,231.0	8,105.0	5.4
Bias light duty	681.1	687.1	705.1	0.5
Bias heavy duty	995.0	995.0	1,014.0	0.4
Bicycle	332.8	339.6	376.0	2.1
Motorcycle	409.5	427.7	507.0	3.5
Other cycles	37.8	38.7	42.3	1.8
Total	16,444.8	17,251.3	20,709.1	3.7

Source: BCC Research

These data are based on BCC Research’s recent estimates and forecasts on global tire output and average elastomer consumption of each tire type. The results of tire output are shown in the following table.

TABLE 5

GLOBAL TIRE OUTPUT BY TYPE, THROUGH 2019
(MILLION UNITS)

Type	2013	2014	2019	CAGR% 2014–2019
Radial light duty	1,369.0	1,423.0	1,668.0	3.2
Radial heavy duty	205.0	222.0	291.0	5.6
Bias light duty	113.0	114.0	117.0	0.5
Bias heavy duty	50.0	50.0	51.0	0.4
Bicycle	832.0	849.0	940.0	2.1
Motorcycle	315.0	329.0	390.0	3.5
Other cycles	42.0	43.0	47.0	1.8
Total	2,926.0	3,030.0	3,504.0	2.9

Source: BCC Research

Automotive Component Elastomers

Automotive elastomers researched in this report include EPDM, CR, NR, SBR, FKM, VMQ/FVMQ, ECO, HNBR, ACM, AEM, BR and TPO/TPV. Typical use in a passenger car is described in the following table.

TABLE 6

TYPICAL ELASTOMERS USED IN AUTOMOBILES BY TYPE
(KILOGRAMS)

Type	Capacity
EPDM	7.6
CR	4.0
NR	2.4
SBR	2.0
FKM	1.2
VMQ/FVMQ	0.8
ECO	0.7
HNBR	0.5
ACM	0.4
AEM	0.3
BR	0.1
TPO/TPV	5.2
Total	25.2

Source: BCC Research

Important rubber components include sealing strips, gaskets, tubes, V-belt, synchronous belts, shock-reducing rubbers and protective rubbers.

Sealing strips comprise the most common automotive use area car contains more than 40 meters worth of rubber sealing strips. The total weight is 3.0 kilograms to 4.0 kilograms.

TABLE 7

GLOBAL AUTOMOTIVE ELASTOMER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
EPDM	542.4	558.8	678.5	4.0
CR	304.7	313.7	383.0	4.1
NR	182.7	188.2	237.1	4.7
SBR	152.2	156.8	185.8	3.5
FKM	91.2	94.0	118.4	4.7
VMQ/FVMQ	60.7	62.6	81.8	5.5
ECO	53.1	54.6	72.8	5.9
HNBR	37.8	39.1	49.9	5 .0
ACM	30.2	31.1	45.3	7.8
AEM	22.6	23.3	36.4	9.3
BR	7.3	7.6	11.7	9.0
TPO/TPV	396.1	407.8	510.7	4.6
Total	1,881.0	1,937.6	2,411.4	4.5

Source: BCC Research

OTHER APPLICATIONS

Other applications include appliances, industry, architectures, medical products, sports products, and resins and materials modification.

Industry

Examples include:

- SBC is used for making shaft seals and rubber gaskets in machinery.
- SBR is used for conveyor belts and hoses.
- BR is used in rubber covered rollers and conveyor belts.
- TPO is used for conveyor belts and tools handles.
- TPVC is used in ventilation pipes, suction hoses and garden hoses.

Appliances

Examples include:

- SBC, SBR, TPV, TPU and TPA are used for wire and cables.
- SBC, TPVC and TPEE are used for protective layer and cushion in appliances.
- TPA is used for silencing gears.

Architecture

Examples include:

- SBC is used as an asphalt modifier and flooring material.
- TPEE is used as a cushion material for bridges.
- TPO is used for waterproof panels and gaskets.
- TPU is used for panels and films.

Sports Products

Examples include:

- SBC is used in handles of ski sticks.
- TPEE is used in inner container of sports balls.
- TPO is used in diving devices.
- SBC and TPU are used in sneakers.

Medical Products

Examples include:

- SBC is used in syringes, blood bags and blood tubes.
- TPVC is used in blood bags and blood tubes.
- TPU is used in condoms.
- TPA is used for catheters.

Elastomers are sometimes modified to meet medical requirements. TPEE is made by terephthalic acid and two or more kinds of glycols to lower toxicity, increase transparency, and make it easy to be processed and sterilized.

Modification

Examples include:

- BR is used as an impact-resistance modifier in making high-impact polystyrene (HIPS) and acrylonitrile butadiene styrene (ABS).

- SBC is used as a modifier to polypropylene (PP), polystyrene (PS) and polypheylene ether (PPE).

- TPU is used a modifier to polyvinyl chloride polymer (PVC), acrylonitrile butadiene styrene (ABS) and polyoxymethylene (POM).

THERMOSET ELASTOMERS

Thermoset elastomers, also known as rubbers, include natural rubber (NR) and synthetic rubbers (SRs). In some countries, the term *synthetic rubber* also includes some types of thermoplastic elastomers such as thermoplastic styrene elastomers (TPSs), also known as styrenic block copolymers (SBCs). This report excludes all thermoplastic elastomers from the Synthetic Rubber and Rubber categories. As a result, SBCs are put in the Thermoplastic Elastomer category.

Recycled rubbers (RRs), also known as reclaimed rubbers, hold a significant market share in some countries, such as China. This report breaks the thermoset elastomer market down to three segments:

- Natural rubbers.
- Synthetic rubbers.
- Recycled rubbers.

Estimates and forecasts of the global rubber market through 2019 are provided in the following table.

TABLE 8

GLOBAL THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
NR	11,520.0	11,910.0	13,770.0	2.9
SRs	13,363.0	13,781.1	16,194.8	3.3
RRs	2,116.2	2,247.3	3,049.4	6.3
Total	26,999.2	27,938.4	33,014.2	3.4

Source: BCC Research

Recycled rubbers include recycled natural rubber (RNR) and recycled synthetic rubber (RSR). The estimates and forecasts for the global recycled rubber market by product are shown in the following table.

TABLE 9

GLOBAL RECYCLED RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs	1,430.9	1,519.8	2,065.5	6.3
NR	685.3	727.5	983.9	6.2
Total	2,116.2	2,247.3	3,049.4	6.3

Source: BCC Research

According to experts, 3.0 metric tons of recycled natural rubber can be used to replace 1 metric ton of natural rubber, and 1.5 metric tons to 2.0 metric tons of recycled synthetic rubber can replace 1 metric ton of synthetic rubber. Therefore, this report assumes 3.0 metric tons of recycled natural rubbers is 1metric ton of natural rubber equivalent, and 1.75 metric tons of recycled synthetic rubbers are equivalent to 1 metric ton of synthetic rubber.

The numbers of recycled rubber volume in the previous table have been converted into *metric ton natural rubber equivalent* and *metric ton recycled rubber equivalent*.

If RNR is put into the NR segment and RSR is put into the SRs segment, the estimates and forecasts of the global thermoset elastomer market will resemble those shown in the following table.

TABLE 10

GLOBAL THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs*	14,793.9	15,300.9	18,260.3	3.6
NR*	12,205.3	12,637.5	14,753.9	3.1
Total	26,999.2	27,938.4	33,014.2	3.4

*NR and SRs here include recycled rubber volume.

Source: BCC Research

Synthetic rubbers include IR, BR, SBR, NBR, CR, IIR, EPM/EPDM, ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

Brief characteristics comparisons of natural rubber and major synthetic rubbers are provided in the following table.

TABLE 11

THERMOSET ELASTOMER CHARACTERISTICS AND PERFORMANCES

Characteristic	NR	SBR	BR	NBR	EPDM	CR	CSM	SIR
Tearing strength	E	E	G	E	G	G	G	F
Weather resistance	F	F	P	F	E	E	E	E
O3 resistance	P	F	P	P	E	G	E	G
Low-temperature resistance	F	F	G	G	E	G	E	E
Thermal resistance	E	G	E	G	E	F	F	E
Flame retardance	P	P	P	P	P	G	G	P
Acid resistance	G	G	G	G	E	F	G	G
Alkali resistance	G	G	G	G	E	G	G	P
Abrasion resistance	E	G	G	E	G	E	E	G
Steam resistance	G	G	G	E	E	P	G	E
Oil resistance	P	P	P	E	P	G	G	P
Chemicals resistance	G	F	P	F	G	G	E	P
Compression set	E	E	G	G	G	E	F	E

*P: poor; F: fine; G: good; E: excellent.

Source: BCC Research

NATURAL RUBBERS

Natural Rubbers, Compounded Rubbers and China

In this report, the *natural rubber* segment includes natural rubber and compounded rubbers.

Natural rubber consists of polymers of organic compound isoprene with impurities of other organic compounds plus water. Commercial natural rubbers include standard rubber and ribbed smoked sheet (RSS).

Compounded rubbers usually consist of 95% to 99.5% natural rubbers, which are mostly polyisoprene, with additional chemicals such as stearic acid, styrene butadiene rubber, synthetic polyisoprene (IR), butadiene rubber (BR), carbon black, peptizers and nihil album. In this report, the volume of compounded rubbers does not include additional chemicals.

Nearly 90% of the world’s natural rubbers are produced in Southeast Asian countries such as Thailand, Malaysia, Indonesia and Vietnam. In 2013, the global natural rubber acreage was nearly 13.1 million hectares, with a total output of 12.4 million metric tons, up 3.8% from the previous year. Asia produced 11.4 million metric tons, maintaining 92% of the global production.

BCC Research estimates the global consumption of natural rubbers was approximately 11.52 million metric tons in 2013. This number is a little bigger than data provided by

other organizations, as the BCC Research report counts in some international trade and consumption going through gray channels. For example, Chinese companies buy 100,000 to 300,000 metric tons of natural rubbers through border trade from Vietnam, Cambodia and Laos per year without paying any import taxes to the government.

China, the world largest tire manufacturing country, consumes more than 40% of the world's natural rubbers. Trends in this market are the most important indicators of trends in the global natural rubber industry.

By the end of 2013, China had 1.1 million hectares of natural rubber acreage, producing 850,000 metric tons of natural rubbers that year.

China's imports of natural rubbers and compounded rubbers in 2013 were 2.47 million metric tons and 1.54 million metric tons, respectively. Assuming the imported compounded rubbers use 96% natural rubber on average, the natural rubber content amounted 1.48 million metric tons. In addition, border trade of natural rubbers, which usually didn't pay import taxes, had approximately 200,000 metric tons. In the same period, China's export of natural rubbers and compounded rubbers totaled 30,000 metric tons.

Based on these data and converting the volumes into solid-state rubber, China's apparent consumption of natural rubbers and compounded rubbers was nearly 4.25 million metric tons in 2013, totally approximately 37% of the global consumption of 11.52 million metric tons.

Compounded rubbers are products of distorted tariff systems. Most are produced because China levies different tax rates on natural rubbers and compounded rubbers.

China sets the import tariffs for ribbed smoked rubber sheets (RSS) at 20% of the value and capped at 1,200 yuan per metric ton. For technically specified natural rubber (TSNR), also known as *standard rubber*, the tax rate was lowered to the same level of RSS since 2013.

China has reduced the import tariffs for compounded rubbers imported from Southeast Asia to zero since 2009. This encourages rapid growth of compounded rubber imports since 2009.

There is, however, a lack of standards for compounded rubbers in China, and thus compounded rubbers are rarely used for making high-performance tires, such as radial tires. Some experts believe most of the compounded rubbers capacity and international trades are not necessary and will vanish once China sets the same import taxes on natural rubbers and compounded rubbers.

Global Natural Rubber Consumption by Region

China, Europe, India, the U.S. and Japan are the main natural rubber consuming countries. Major natural rubber producers such as Indonesia, Thailand, Malaysia and Vietnam are also experiencing growing natural rubber consumption, as the global industrial chain has moved some of the capacity of rubber products to these regions.

This report breaks the global natural rubber market down into five regions: China, Asia, North America, Europe and Others. The Others segment includes South America, Africa, Australia and New Zealand.

TABLE 12

GLOBAL NATURAL RUBBER MARKET BY REGION, THROUGH 2019
(THOUSAND METRIC TONS)

Region	2013	2014	2019	CAGR% 2014–2019
China	4,250.0	4,520.0	5,750.0	4.9
Asia	4,120.0	4,230.0	4,820.0	2.6
Europe	1,380.0	1,380.0	1,350.0	-0.4
North America	1,080.0	1,080.0	1,050.0	-0.6
Others	690.0	700.0	800.0	2.7
Total	11,520.0	11,910.0	13,770.0	2.9

Source: BCC Research

Nearly two-thirds of the growth of global natural rubber consumption in the next five years will be from China.

Estimates of natural rubber consumption and its 2013 percentage in major countries are provided in the following table.

TABLE 13

NATURAL RUBBER CONSUMPTION BY COUNTRY, 2013
(THOUSAND METRIC TONS/%)

Country	Consumption	Percent
China	4,250	36.9
Europe	1,080	9.4
India	950	8.2
U.S.	890	7.7
Japan	700	6.1
Indonesia	600	5.2
Thailand	510	4.4
Malaysia	450	3.9
South Korea	360	3.1
Others	1,730	15.0
Total	11,520	99.9

Source: BCC Research

Global Natural Rubber Production by Region

Estimates of 2013 global natural rubber production by country are shown in the following table.

TABLE 14

GLOBAL NATURAL RUBBER PRODUCTION BY REGION, 2013
(THOUSAND METRIC TONS/%)

Region	Production	Percent
Thailand	4,010	32.3
Indonesia	3,180	25.6
Vietnam	950	7.7
China	850	6.9
India	840	6.8
Malaysia	830	6.7
Sri Lanka	130	1.0
Africa	550	4.4
South America	220	1.8
Other countries	140	1.1
Total	11,700	94.3

Source: BCC Research

The previous table shows that China is the world's largest net importing country of natural rubber, and Thailand is the largest net exporter.

SYNTHETIC RUBBERS

Synthetic rubbers are thermoset elastomers mainly produced from petroleum byproducts. This segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, ERP and Others. The ERP section includes EPM and EPDM. The Others section is mostly comprised of saturated rubbers with relatively small volumes, including ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

Estimates and forecasts of the global synthetic rubber market are provided in the following table.

TABLE 15

GLOBAL SYNTHETIC RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SBR	4,919.0	5,036.6	5,722.2	2.6
BR	3,314.0	3,443.2	4,185.0	4.0
EPR	1,276.0	1,317.4	1,558.3	3.4
IIR	1,222.0	1,270.1	1,556.3	4.1
NBR	562.0	580.7	688.2	3.5
IR	635.0	652.8	754.1	2.9
CR	293.0	297.0	318.7	1.4
Others	1,142.0	1,183.3	1,412.0	3.6
Total	13,363.0	13,781.1	16,194.8	3.3

Source: BCC Research

SBR will remain the largest segment in the following five years, but its market share will decline.

Global Styrene Butadiene Rubber Market

Styrene butadiene rubber (SBR) is a copolymer of styrene and butadiene. It is the world's largest synthetic rubber family. Major types include emulsion-polymerized styrene butadiene rubber (ESBR) and solution polymerized styrene butadiene rubber (SSBR).

Estimates and forecasts of global SBR consumption by major types through 2019 are provided in the following table.

TABLE 16

GLOBAL STYRENE BUTADIENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
ESBR	3,734.0	3,787.6	4,084.2	1.5
SSBR	1,185.0	1,249.0	1,638.0	5.6
Total	4,919.0	5,036.6	5,722.2	2.6

Source: BCC Research

ESBR will continue to maintain most of the market share, but SSBR will experience a much faster growth.

Globally, oil-extended ESBR accounts for approximately 60% of total ESBR consumption. Oil-extended ESBR has lower heat generation, better processability and better flex resistance compared to the non-oil-extended version. When used for tread, oil-extended ESBR has better traction performance and abrasion resistance. Oil-extended ESBR is mostly used for making tire treads and side walls.

Major SBR applications include tires, automotive components, conveyer belts, hoses, tapes, footwear, medical products and modifiers.

Most of the world's SBR is used for tire manufacturing. Estimates and forecasts of global SBR consumption by major applications through 2019 are provided in the following table.

TABLE 17

GLOBAL STYRENE BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014-2019
Tires	3,198.3	3,277.2	3,788.5	2.9
Automotive	152.2	156.8	185.8	3.5
Others	1,568.6	1602.6	1,747.9	1.7
Total	4,919.0	5,036.6	5,722.2	2.6

Source: BCC Research

In tire applications, SBR is mostly used for treads, side walls and carcasses. SBR is widely used for tires in passenger cars, tractors and motorcycles. SBR is rarely used for heavy-duty tires.

In automotive applications, SBR is used for making hoses, V-belts, synchronous belts, O rings, sealing strips and shock-reducing rubber.

Other applications include footwear, conveyer belts, hoses, tapes, medical products and modifiers.

Styrene Butadiene Rubber Producers

- *Emulsion-Polymerized Styrene Butadiene Rubber Producers*

Leading global ESBR manufacturers include China National Petroleum Corporation (CNPC), Kumho Tires and Sinopec. These three companies take produce one-third of the world's capacity.

Capacities of leading ESBR manufacturers and their market shares are provided in the following table.

TABLE 18

LEADING EMULSION-POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS/%)

Company	Capacity	Percent
CNPC	500.0	10.0
Kumho	480.0	9.6
Sinopec	450.0	9.0
Goodyear	360.0	7.2
Ashland	240.0	4.8
Shenhua	180.0	3.6
Total	2,210.0	44.0
World total	5,020.0	100.0

Source: BCC Research

Lanxess, another major ESBR producer, had a total capacity of 256,000 metric tons of ESBR per year in Brazil, but the company decided to convert production of ESBR used in standard tires to SSBR used in high-performance *green* tires. Its site in Triunfo (Rio Grande do Sul) in southern Brazil stopped producing ESBR to produce the latest grades of SSBR at the end of 2014, with an annual capacity of 110,000 metric tons.

- *Solution Polymerized Styrene Butadiene Rubber Producers*

Leading SSBR manufacturers include Styron, Firestone, Michelin, Japan Synthetic Rubber and Goodyear. These four companies produce more than 40% of the world’s capacity. Firestone was purchased by Bridgestone. Lanxess and CNPC are also important players.

Capacities of leading SSBR manufacturers and their market shares are provided in the following table.

TABLE 19

LEADING SOLUTION POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013
(THOUSAND METRIC TONS/%)

Company	Capacity	Percent
Firestone (Bridgestone)	180.0	11.9
Styron	160.0	10.6
Michelin	130.0	8.6
Goodyear	130.0	8.6
Lanxess	110.0	7.3
CNPC	100.0	6.6

Sinopec	90.0	6.0
Total	900.0	59.6
World total	1,510.0	100.0

Source: BCC Research

Styrene Butadiene Rubber Technologies

Leading players in the SBR R&D include Goodyear, Bridgestone, Japan Synthetic Rubber Co. Inc., BASF, Dow Chemical and ZEON. They license their manufacturing technologies and patents to manufacturers in Asia, South America and Africa.

Technological trends of emulsion-polymerized styrene butadiene rubber include:

- Higher monomer conversion percentage.
- New functional monomers for improving rubber performance.
- New types of emulsifiers and conditioning agents.
- Environmentally friendly termination agents.
- Powder manufacturing method.

Most manufacturers use technologies based on Phillips' batch polymerization method for SSBR production. A small portion uses continuous polymerization process based on Firestone method. Firestone is now part of Bridgestone.

Technological innovations of SSBR mainly focus on microstructure control. An example is developing a functional SSBR with high ethylene content and moderate and controllable styrene content by using new types of multifunctional initiators, couplers and conditioning agents.

Global Butadiene Rubber Market

Butadiene rubber (BR) is an elastomer polymerized by 1,3-butadiene monomers, which is a conjugated diene with the formula C_4H_6.

BR is mostly used for making tires. It is also used as an impact-resistance modifier in making high-impact polystyrene (HIPS) and acrylonitrile butadiene styrene (ABS).

Estimates and forecasts of global BR consumption by application through 2019 are provided in the following table.

TABLE 20

GLOBAL BUTADIENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
Tires	2,286.5	2,378.7	2,919.6	4.2
HIPS	389.7	403.9	483.6	3.7
ABS	124.1	128.8	154.8	3.7
Others	513.7	531.8	627.0	3.3
Total	3,314.0	3,443.2	4,185.0	4.0

Source: BCC Research

In tire applications, BR is mostly used for making treads and side walls. Nd-BR is a promising type due to its advantages, including high tensile strength, low heat generation, low hysteresis loss, excellent flex resistance and wet traction, and low rolling resistance.

As an impact-resistance modifier for HIPS, the additive BR equals 5% to 8% of HIPS in terms of volume.

As a modifier for making ABS, one kilogram of ABS is added with 0.1 kilograms to 0.2 kilograms of BR.

BR is also used for making hoses, belts, sports products, automotive parts and other products.

Butadiene Rubber Producers

Major BR producers include Sinopec, Lanxess, Kumho, Michelin, Goodyear, UBE, Eni, CNPC and Sibur. Their capacities and shares are provided in the following table.

TABLE 21

LEADING BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013
(THOUSAND METRIC TONS/%)

Company	Capacity	Percent
Sinopec	550.0	12.4
Lanxess	440.0	9.9
Kumho	420.0	9.4
Michelin	280.0	6.3
Goodyear	270.0	6.1
UBE	270.0	6.1
Eni	190.0	4.3
CNPC	160.0	3.6

Sibur	160.0	3.6
Others	2,740.0	61.6
World total	4,450.0	100.0

Source: BCC Research

Butadiene Rubber Technologies

The world's leading players in BR R&D include UBE, Goodyear, Bridgestone, Japan Synthetic Rubber and Lanxess.

- *Ti-BR:* The only large Ti-BR producer is the Russia-based Sibur. This technology could be phased out in the future.
- *Co-BR:* Technological innovations focus on making syndiotactic 1,2 polybutadiene with different crystallinity and melting temperatures.
- *Ni-BR:* The focus is on high cis-hyperbranched BR.
- *Li-BR:* The focus is on developing low-cis BR (LCBR) with different ethylene content.
- *Nd-BR:* The focuses include advanced initiating systems and related polymerization processes, as well as chain-end modification technologies.
- *Others:* Other important trends include making high ethylene content BR by using Mo or Fe initiating systems.

Global Nitrile Rubber market

Nitrile rubber (NBR), also known as acrylonitrile butadiene rubber, Buna-N and Perbunan, is a copolymer of acrylonitrile (ACN) and butadiene. Major types include hydrogenated nitrile rubbers (HNBR), powder nitrile rubbers (PNBR) and carboxylated nitrile rubbers (XNBR).

Estimates and forecasts of global NBR consumption by major products through 2019 are provided in the following table.

TABLE 22

GLOBAL NITRILE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
PNBR	82.3	84.4	96.9	2.8
HNBR	58.4	60.4	77.2	5.0
Others	421.3	435.9	514.1	3.4
Total	562.0	580.7	688.2	3.5

Source: BCC Research

Major NBR products include hoses, belts, wire and cable, O rings, adhesives, sealants, footwear and molded products. Many of these products are used in automobiles.

More than 60% of the world's HNBRs are used for automotive applications. Estimates and forecasts of global HNBR consumption and automotive applications through 2019 are provided in the following table.

TABLE 23

GLOBAL HYDROGENATED NITRILE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	37.8	39.1	49.9	5.0
Others	20.6	21.3	27.3	5.1
Total	58.4	60.4	77.2	5.0

Source: BCC Research

An automobile usually consumes 0.3 kilograms to 0.6 kilograms of HNBR. The global consumption of HNBR is more than 10,000 metric tons.

Nitrile Rubber Producers

The leading global players for NBR production and R&D include Lanxess, ZEON, Bayer, Sinopec, Sibur, JSR and Polimeri. ZEON NBR's trade name is Nipol, and Lanxess' NBR is marketed under the trade name Krynac.

Leading global NBR producers and their capacity shares are shown in the following table.

TABLE 24

LEADING GLOBAL NITRILE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013 (THOUSAND METRIC TONS/%)

Company	Capacity	Percent
Lanxess	155.0	18.7
ZEON	110.0	13.3
Sinopec	70.0	8.4
Sibur	41.0	4.9
JSR	40.0	4.8
Total	416.0	50.2
World total	829.0	100.0

Source: BCC Research

Lanxess leads in global NBR production. Its facilities based in France, Canada and China cover Europe, North America and Asia. The world's five largest producers contribute more than half of global capacity.

Nitrile Rubber Technologies

The leading global NBR R&D players include Lanxess, Bayer, ZEON and Eni.

Major advances of NBR R&D include polymerization formula, polymerization methods, automatic control technologies and new grades of products.

- The focuses of improved polymerization formulas are high-efficiency and environmentally friendly formulas.
- New products are specialized and differentiated NBR for different applications. They include chain-end NBR, carboxylated nitrile rubber (XNBR), fast-vulcanized NBR, hydrogenate NBR (HNBR), third monomer-copolymerized NBR and powder NBR.

Global Isobutylene Isoprene Rubber Market

Isobutylene isoprene rubber (IIR), also known as butyl rubber, is a copolymer of isobutylene and isoprene. IIR has excellent impermeability and good flex properties. Its air permeability is only one-seventh of natural rubber and one-fifth of styrene butadiene rubber. Its steam permeability is only 1/200 of natural rubber and 1/140 of styrene butadiene rubber.

Most IIR is halogenated. The halogenated IIR (HIIR) include chloro isobutylene isoprene rubber (CIIR) and bromo isobutylene isoprene rubber (BIIR).

Estimates and forecasts of global IIR and HIIR consumption through 2019 are provided in the following table.

TABLE 25

GLOBAL ISOBUTYLENE ISOPRENE RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
HIIR	909.7	947.9	1166.9	4.2
Others	312.3	322.2	389.4	3.9
Total	1,222.0	1,270.1	1,556.3	4.1

Source: BCC Research

Major NBR products include tires, electric insulation materials, medical bottle plugs, gas masks and sealing materials.

Roughly two-thirds of the world’s HIIR is used for tires. Estimates and forecasts of global HNBR consumption and automotive applications through 2019 are provided in the following table.

TABLE 26

GLOBAL HALOGENATED ISOBUTYLENE ISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	661.4	691.0	865.8	4.6
Others	248.4	256.9	301.1	3.2
Total	909.7	947.9	1166.9	4.2

Source: BCC Research

In tire application, IIR is mostly used for making inner liners and inner tubes.

Isobutylene Isoprene Rubber Producers

Exxon Mobil and Lanxess are the world’s two largest IIR producers. Exxon Mobil produces nearly half of the world’s capacity with its subsidiaries and joint ventures.

Leading global IIR manufacturers and their capacities are shown in the following table.

TABLE 27

LEADING ISOBUTYLENE ISOPRENE RUBBER MANUFACTURERS BY CAPACITY, 2013 (THOUSAND METRIC TONS/%)

Company	Capacity	Percent
Exxon Mobil, U.S.	290.0	21.5
JSC, Japan	178.0	13.2
Lanxess, Canada	150.0	11.1
Lanxess, Belgium	150.0	11.1
Sinopec, China	135.0	10.0
Exxon Mobil, U.K.	110.0	8.2
Nizhnekamsk, Russia	100.0	7.4
Lanxess, Singapore	100.0	7.4
Socabu, France	70.0	5.2
Togliattikauchub, Russia	60.0	4.5
Pitesti, Romania	5.0	0.4
World total	1,348.0	100.0

Source: BCC Research

With its subsidiaries, ExxonMobil is the world's largest IIR producer.

ExxonMobil has two plants in the U.S.: one in Baton Rouge, Louisiana and another at Baytown, Texas. These two plants have a total capacity of nearly 290,000 metric tons of IIR per year. ExxonMobil has a capacity of nearly 110,000 metric tons of IIR at Fawley, U.K.

Lanxess is the world's second-largest IIR producer. It has three plants. In 2012, it expanded the production capacity of its plant in Zwijndrecht, Belgium by 10% to 150,000 metric tons per year. In 2013, it launched a new IIR plant in Jurong Island, Singapore, with a total capacity of 100,000 metric tons per year. Lanxess has another IIR plant in Sarnia, Canada, with a capacity of 150,000, metric tons per year.

Japan Butyl Co. Ltd. (JBC) is a joint venture of ExxonMobil Yugen Kaisha (EMYK) and JSR Kabushiki Kaisha. The company serves as a supply base for butyl rubber primarily in Asia, with a capacity of 145,000 metric tons per year. ExxonMobil Yugen Kaisha holds a 50% stake in Japan Butyl Co. Ltd. EMYK is an affiliate of ExxonMobil Chemical.

In 2010, JBC completed a major expansion to increase butyl rubber production capacity at its plant in Kawasaki, Japan. The expansion added 18,000 tons per year of production capacity, bringing the plant's total capacity to 98,000 tons per year.

In 2013, JBC expanded the capacity of its halobutyl rubber manufacturing plant at Kashima, Japan to 80,000 tons per year.

Therefore, JBC currently has a total annual capacity of 178,000 tons of IIR.

Sinopec Beijing Yanshan Company put its new facility of IIR into trial production on December 5, 2013. The new facility has an annual capacity of 90,000 metric tons of HIIR.

The company's other facility has a capacity of 45,000 metric tons of IIR, giving it a total capacity of 135,000 metric tons of IIR per year.

Isobutylene Isoprene Rubber Technologies

The world's leading players for IIR R&D include Exxon Mobil, Lanxess, and Bayer.

IIR R&D mainly focuses on advanced initiating systems, high polymerization temperature, improved reactors and new product development.

Global Ethylene Propylene Rubber Market

Ethylene propylene rubber (EPR) includes ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM). EPR is resistant to heat, oxidation, ozone, steam, chemicals and weathering.

EPR can be used at temperatures from -55°C to 150°C. At 120°C, EPR can be used for a long period. Above 120°C, the aging of EPR could be accelerated, and the service life will be shortened. EPR can be used under worse conditions by oxide crosslinking.

EPR has excellent electrical insulation properties. It has low density (0.87) and can be filled with oil and other materials to lower costs. For high-Mooney viscosity EPR, filling with other materials won't reduce EPR's mechanical properties by a significant amount.

The disadvantages of EPR include poor oil resistance and long cure time, which is three- to four-times longer than most of other synthetic rubbers. In addition, EPR has low adhesiveness to itself and other materials, which makes it difficult to be processed.

Estimates and forecasts of global EPR consumption by product through 2019 are provided in the following table.

TABLE 28

GLOBAL ETHYLENE PROPYLENE RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
EPDM	1,107.5	1,143.2	1,353.4	3.4
EPM	168.5	174.2	204.9	3.3
Total	1,276.0	1,317.4	1,558.3	3.4

Source: BCC Research

EPR is used for automotive components, blend modification, architecture, wire and cable, and tires.

Estimates and forecasts of global EPR consumption by application through 2019 are provided in the following table.

TABLE 29

GLOBAL ETHYLENE PROPYLENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	542.4	558.8	678.5	4.0
Blend modification	171.5	176.6	201.8	2.7
Architecture	136.8	140.4	160.6	2.7
Wire and cable	88.8	91.7	106.0	2.9
Tires	31.6	32.9	40.3	4.1
Other	305.0	317.0	371.1	3.2
Total	1,276.0	1,317.4	1,558.3	3.4

Source: BCC Research

EPR is the most widely-used automotive rubber (except for tire applications). In this field, EPR is used for making sealing strips for automotive doors and windows, ventilation pipes of air conditioners, seal components and hoses.

For a blend modification application, EPR is used to improve other rubbers or polymers' resistance to heat, oxidation, ozone, steam and low temperature.

In architectural application, EPR is used for waterproof rolls, sealing strips and sports tracks.

Ethylene Propylene Rubber Producers

North America, Asia and Europe dominate the world's production of EPR. Major EPR producers include Exxon Mobil, Mistsui Chemicals, Lanxess, Dow Chemical, Crompton, Herdillia, Kumho, Mitsui Chemicals, Versalis (former Polimeri Europa) and Sumitomo Chemical.

Capacities and shares of major manufacturers from 2012 to 2013 are shown in the following table.

TABLE 30

LEADING ETHYLENE PROPYLENE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013
(THOUSAND METRIC TONS)

Company	Location	Capacity	Trade Name	Method
Exxon Mobil U.S.	Baton Rouge, U.S.	180.0	Vistalon	Solution
Lanxess (DSM)	Geleen, The Netherlands	160.0	Keltan	Solution
Dow Chemical	Plaquemine, U.S.	140.0	Nordel IP	Solution
Lion Copolymer	Geismar, U.S.	134.0	Royalene	Solution
Mitsui Chemicals	Japan	120.0	Mitsui EPT	Solution
Exxon Mobil France	France	85.0	Vistalon	Solution
Polimeri Europa (Eni)	Ferrara, Italy	85.0	Dutral	Suspension
Lanxess U.S.	Ornage, U.S.	70.0	Buna EP	Suspension
Lanxess Germany	Marl, Germany	70.0	Buna AP	Solution
Sinopec	China	70.0	Shuangli	Solution
Kumho	South Korea	50.0	Vistalon	Solution
Sumitomo Chemical	Japan	43.0	Esprene	Solution
Lanxess (DSM) Brazil	Brazil	42.0	Keltan	Solution
SK	South Korea	40.0	Suprene	Solution
JSR	Japan	36.0	JSR EP	Solution
Nizhnekamskneftekhim	Russia	30.0	Elastokam	Solution
Herdilla	India	11.0	Herlene	Solution
Total		1,366.0		

Source: BCC Research

Polimeri Europa, a subsidiary of Eni, changed its name to Versalis in 2011.

After selling its SBR facility to East West Copolymer, Lion Copolymer plans to increase its capacity by 66,000 to 88,000 metric tons per year. With the additional capacity, Lion Copolymer’s total capacity will exceed 200,000 metric tons per year.

Sinopec Jilin Company is the only EPDM producer in China. Another new entrant will be Shanghai Sinopec Mitsui Elastomers Co. Ltd. (SSME), a 50:50 joint venture of Sinopec and Mitsui Chemicals. SSME’s EPDM plant was completed May 2014 and put into production in November 2014, with an annual capacity of 75,000 metric tons per year.

Ethylene Propylene Rubber Technologies Research and Development

The leading global players for EPR R&D include Exxon Mobil, Lanxess, Mistsui Chemicals and Bayer. The solution polymerization method dominates the global EPR production.

EPR R&D mainly focuses on advanced initiating systems and polarization modification.

- The initiating systems have moved from the V and Ti systems of the Ziegler-Natta series to metallocene and low-valence homogeneous systems.

- Polarization modification is usually used for improving EPR's compatibility to other rubbers and materials. Examples include chloration, sulfonation and blending modifications with organic silicon and nylon.

Global Polyisoprene Rubber Markets

Polyisoprene rubber (IR) is a synthetic rubber with similar properties to natural rubber. In some countries, it is called *synthetic natural rubber*. It has better water resistance and electrical insulation than natural rubber, but the strength, adhesiveness and processability of raw rubber and the tearing strength and fatigue resistance of cured rubber are usually slightly lower than natural rubber.

Estimates and forecasts of global IR consumption by application through 2019 are provided in the following table.

TABLE 31

GLOBAL POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	495.7	510.1	590.3	3.0
Machinery	78.7	80.5	91.1	2.5
Footwear	13.4	14.0	16.8	3.7
Adhesive or sealant	19.2	19.7	23.0	3.1
Others	28.0	28.5	32.9	2.8
Total	635.0	652.8	754.1	2.9

Source: BCC Research

For tire application, IR is used in tread, side wall, carcass, inner liner, belt ply and tire shoulder.

Synthetic Polyisoprene Producers

Major global IR producers include NKNH, Sibur (Togliattikauchuk), Goodyear and Sinopec. Leading producers and their capacities are listed in the following table.

TABLE 32

LEADING SYNTHETIC POLYISOPRENE MANUFACTURERS BY CAPACITY, 2013 (THOUSAND METRIC TONS)

Company	Capacity	Percent
NKNH	200.0	25.9
Kauchuk Sterlitamak	100.0	13.0
Goodyear, U.S.	90.0	11.7
Qingdao Yikesi	70.0	9.1
Togliattikauchuk	60.0	7.8
Panjin Zhenao	50.0	6.5
Zibo Luhua	50.0	6.5
ZEON, Japan	40.0	5.2
JSR, Japan	36.0	4.7
TPI	30.0	3.9
Kraton, The Netherlands	25.0	3.3
Maoming Luhua	15.0	2.0
Karbochem, South Africa	3.0	0.4
Total	769.0	100.0

Source: BCC Research

For decades, Russia (and the former Soviet Union) has been actively developing IR for its tire industry. Today, Russia once accounted for more than half of the world's IR capacity and consumption. Nizhnekamskneftekhim (NKNH) is the world's largest IR supplier, with an annual capacity of 200,000 metric tons. Russia still maintains more than 45% of the global capacity despite a challenge for supremacy from the fast-growing Chinese capacity.

China didn't produce IR before 2010. Since 2010, five Chinese companies have been actively set up and have expanded their IR capacity, which reached a total of 215,000 metric tons per year by 2013. It is estimated that China will soon surpass Russia, becoming the world's largest IR producing countries.

Synthetic Polyisoprene Technologies

The world's leading players for IR R&D include Goodyear, Bayer, Japan Synthetic Rubber and Kuraray.

Technological IR trends include:

- *Li-IR:* Cis contents could be increased by introducing active components into lithium initiator. Cis content is increased to more than 98% by using n-BuLi with 1, 3-dibromobenzene and triphenylamine

- *Ti-IR:* Ti-based initiators may become the most popular initiators. An example is $TiCl_4$-AIR_3 initiator, which can be added with synergistic-effect third

component for improving system activity. Chinese companies use Ti-based initiators to produce Trans-1, 4 polyisoprene (TPI), which has been successfully used for replacing natural rubbers in heavy-duty tires.

- *Nd-IR:* Many companies engage in the innovation and optimization of Nd-based initiating systems and polymerization processes.

Global Chloroprene Rubber Markets

Chloroprene rubber, also known as polychloroprene or Neoprene, the trade name given by DuPont, is a synthetic rubber produced by polymerization of chloroprene. It has good chemical stability and maintains flexibility over a wide temperature range.

CR has good mechanical properties and is resistant to oil, heat, flame, sunlight, ozone, acid, alkali and chemicals.

The disadvantages of CR include its relatively bad low-temperature resistance and poor electrical insulation. In addition, CR has low storage stability. The so-called *bin cure* happens in storage of raw CR rubber, which increases Mooney viscosity and makes the rubber harder.

Major applications of CR rubber include adhesives for footwear and architecture, industrial products (e.g., hoses and belts, sealing strips and pads, white-wall tires, cycle tires), and wire and cable.

Estimates and forecasts of the global CR market by application are provided in the following table.

TABLE 33

GLOBAL CHLOROPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Industrial products	156.2	157.8	168.1	1.3
Adhesives	93.4	95.3	103.5	1.7
Wire and cable	43.4	43.9	47.1	1.4
Total	293.0	297.0	318.7	1.4

Source: BCC Research

Chloroprene Rubber Producers

Major global CR producers include Denka, DuPont and Lanxess. Global CR capacity reached the historical height of 800,000 metric tons in the 1980s. From the early 1990s to the mid-2000s, however, CR products were gradually replaced by EPR and other rubbers,

especially in automotive applications, and capacity dropped significantly. After 2005, CR demands from Asia, (especially China) re-grew due to the booming automobile and real estates markets there. It's estimated that global CR capacity will continue slow growth in the following five years.

Leading CR manufacturers and their capacities are listed in the following table.

TABLE 34

LEADING CHLOROPRENE RUBBER MANUFACTURERS BY CAPACITY, 2013 (THOUSAND METRIC TONS/%)

Company	Capacity	Percent
DuPont, U.S.	100	23.8
Denka, Japan	70	16.6
Shanxi Synthetic Rubber	65	15.4
Lanxess, Germany	63	15.0
Nairit, Armenia	34	8.1
Tosoh, Japan	34	8.1
Chongqing Changshou	30	7.1
Showa Denka	25	5.9
World total	421	100.0

Source: BCC Research

DuPont's capacity fell to 100,000 metric tons per year after it closed its Louisville-based CR facility.

In July 2014, Lanxess completed an expansion of its Baypren solid CR production operation in Dormagen, Germany, increasing the annual capacity of solid CR by 10% to 63,000 metric tons.

Denka and its subsidiary Showa Denka have a total capacity of 95,000 metric tons per year.

Important expansion in the next few years will be solely from China, including:

- Chongqing Changshou will increase 40,000 metric tons of annual capacity.
- Sichuan Changning will set up a new facility with 50,000 metric tons per year.
- A facility located in Dongyinggang, China will have a capacity of 20,000 metric tons per year, and a plant in Inner Mongolia will have 20,000 metric tons per year.

Chloroprene Rubber Technologies

The leading global players for CR R&D include Denka, DuPont, Bayer and Lanxess.

The raw materials of CR are toxic and cause considerable damage to the environment, so CR has higher environmental costs than most of other synthetic rubbers. In addition, the manufacturing process is relatively long and costly, so CR has been gradually replaced by other rubbers.

CR is still widely used in adhesives. R&D for CR currently focuses on graft modification of solvent-type CR. Graft modification improves the bonding ability between CR and some types of advanced materials. Powder technology is another direction for CR innovations.

Global Markets for Other Synthetic Rubbers

Other important synthetic rubbers include ECO, AEM, FKM, silicone rubber (SIR) and ACM. In this report, silicone rubber includes fluorosilicone rubber (FVMQ).

Globally, nearly one-third of these rubbers are used for automotive purposes (except for tire applications). Estimates and forecasts of synthetic rubbers used for automotive purposes are shown in the following table.

TABLE 35

GLOBAL OTHER SYNTHETIC RUBBER AUTOMOTIVE APPLICATIONS BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
FKM	91.2	94.0	118.4	4.7
SIR	60.7	62.6	81.8	5.5
ECO	53.1	54.6	72.8	5.9
ACM	30.2	31.1	45.3	7.8
AEM	22.6	23.3	36.4	9.3
Total	257.8	265.6	354.7	6.0

Source: BCC Research

Fluorocarbon Rubber

Fluorocarbon rubber (FKM) is resistant to high temperatures, ozone, oxygen, oil and many other chemicals. Under dynamic conditions, the lowest service temperature is roughly 15°C (5°F). Gas permeability is very low and similar to that of butyl rubber. Special FKM compounds exhibit an improved resistance to acids and fuels.

Globally, approximately 60% of FKM is used for the automotive industry. Major applications include fuel hoses, gas pipes, fuel pump and jet device seals, valve stem seals, dynamic seals, piston seals, crankshaft oil seals, universal joint gaskets, O rings and air conditioning compressor seals. An automobile could use 0.2 kilograms to 1.6 kilograms of FKM.

Epichlorohydrin Rubber

Epichlorohydrin (ECO) is copolymer or homopolymer with similar properties to nitrile rubber, but with better oil and heat resistance. It has low gas permeability and better low-temperature flexibility than NBR. It is resistant to acids, alkalis and ozone. Disadvantages of ECO include poor compression set and corrosive effect on metals.

ECO was first developed by two U.S. companies—Goodrich and Hercules—in 1960s. Goodrich produced ECO under the trade name Hydrin, and Hercules produced it under the trade name Herclor. ZEON entered the ECO industry in the 1970s under an agreement with Hercules and another Japanese company. Hydrin currently belongs to ZEON.

ZEON's Hydrin polymers are used for fuel oil-resistant applications for automobile gaskets, hoses and diaphragms, as well as for printer rolls and anti-static applications.

Fluorosilicone Rubber

Fluorosilicone rubber FVMQ contains trifluoropropyl groups next to the methyl groups. The mechanical and physical properties are very similar to VMQ. FVMQ offers improved fuel and mineral oil resistance, but poor hot air resistance when compared with silicone rubber (VMQ).

THERMOPLASTIC ELASTOMERS

Thermoplastic elastomers (TPEs) include SBC (also known as TPS), TPO, TPV, TPEE, TPU, TPA, TPVC and MPR.

CHARACTERISTICS AND ADVANTAGES

The main characteristics and performances of major TPEs are listed in the following table.

TABLE 36

THERMOPLASTIC ELASTOMER CHARACTERISTICS AND PERFORMANCES

Thermoplastic Elastomer	SBC	TPO	TPU	TPEE	TPV	TPVC	TPA
Density	0.9-1.2	0.9-1.0	1.1-1.3	1.1-1.3	0.9-1.0	1.2-1.3	1.1-1.2
Low-temperature resistance	-70	-60	-50	-65	-60	-50	-40
Heat resistance	100	120	135	160	135	110	120

Compression set	P	P	G	F	E	F	G
Aqueous solution resistance	E	E	G	G	E	E	G
Hydrocarbon solvent resistance	P	P	E	E	E	G	E

*P: Poor; F: Fine; G: Good; E: Excellent.

Source: BCC Research

In many applications, TPEs are advanced and provide better replacement than TSEs. Advantages of TPEs over TSEs include:

- TPEs have simpler manufacturing methods for making end products. For example, making automobile rubber seal strips from ethylene propylene diene monomer (EPDM) requires three steps: mixed compounding, molding and high-temperature vulcanization. Making the product from TPE only needs a direct molding step. Simpler manufacturing methods largely increase production efficiency.

- TPE saves energy. Processing $1,000 worth of synthetic rubbers usually consumes more than one metric ton of standard coal equivalent. According to an automotive manufacturer, the three steps for making one kilogram of EPDM automobile rubber seal strips could consume 2.2 kilohertz to 2.3 kilohertz.. The single molding step for making TPE automobile rubber seal strips usually consumes no more than 0.6 kilohertz per kilogram. The TPE route reduces energy by nearly 75%. Likewise, when compared to making CR automobile dustproof covers, the TPE route could reduce energy consumption by 70% to 80%.

- TPE is recyclable. More than 20 million metric tons of waste rubbers per year globally. TPE is more recyclable than synthetic rubber, making it more environmentally friendly.

THERMOPLASTIC ELASTOMER HISTORY

DuPont and Bayer developed the first-generation thermoplastic polyurethanes (TPUs) in 1960. Throughout the 1960s, Shell, Mitsubishi and Monsanto developed other types of TPE, such as thermoplastic polyolefins (TPOs).

In early 1972, Uniroyal improved the TPO manufacturing method. During the same period, DuPont started to produce thermoplastic polyester elastomer (TPEE), and Shell developed SEBS. In the mid-1970s, Japan Synthetic Rubber developed thermoplastic 1,2-poly-butadiene elastomer

In the early 1980s, Monsanto started to produce TPV, and Atochem developed TPA. In the late 1980s, Shell started to produce SEBS with functional groups.

THERMOPLASTIC ELASTOMERS PROUCTS

This report divides the TPE market to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs with relatively small volumes of consumption, including TPA, TPVC and MPR.

Global Styrenic Block Copolymers Market

SBC is the most widely used thermoplastic elastomer. Major SBC types include SBS, SEBS, SIS and SEPS.

Hydrogenated SBCs, including styrene ethylene butylene styrene (SEBS) and styrene ethylene propylene styrene (SEPS), are relatively new SBC types. They have advantages such as better aging resistance and tensile properties than un-hydrogenated SBCs.

Major applications include adhesives and sealants, asphalt modifiers, polymer modifiers, viscosity index (VI) improvers and footwear. Estimates and forecasts of the global SBC market by application are listed in the following table.

TABLE 37

GLOBAL STYRENIC BLOCK COPOLYMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Adhesives and sealants	386.9	402.2	495.2	4.2
Asphalt modifiers	603.1	627.3	783.6	4.5
Polymer modifiers	214.4	223.3	273.4	4.1
Viscosity index improvers	23.2	24.1	29.7	4.3
Footwear	452.7	478.6	619.1	5.3
Others	214.7	223.4	270.7	3.9
Total	1,895.0	1,978.8	2,471.7	4.5

Source: BCC Research

Styrenic Block Copolymers Producers

Major global SBC producers include Sinopec, Kraton and LCY Group. Facilities and their capacities are listed in the following table.

TABLE 38

LEADING STYRENIC BLOCK COPOLYMER MANUFACTURERS BY CAPACITY, 2013 (MILLION METRIC TONS)

Company	Capacity	Products
Sinopec, China	450	SBS/SIS/SEBS
LCY, China	300	
Kraton, U.S.	200	SBS/SEBS/SIS/SEPS
LCY, Taiwan	140	SBS/SIS/SEBS
Dynasol, Spain	110	SBS/SEBS
Kraton, Germany	100	SBS
Chevron Phillips Chemical, U.S.	100	
Other Taiwanese companies	100	SBS
CNPC, China	100	SBS/SIS/SEBS
Eni (Polimeri), Italy	90	SBS/SIS/SEBS
Kraton, France	90	SBS/SIS/SEBS
Kumho, South Korea	70	SBS/SEBS
LG, South Korea	70	SBS
Other Japanese companies	70	SBS/SIS/SEBS
Dexco, U.S.	60	SBS/SIS/SIBS
LCY, U.S.	60	SBS/SIS
Asahi Kasei, Japan	60	SBS/SEBS
TSRC, Taiwan	60	SBS/SIS/SEBS
Other European producers	50	
Kraton-JSR	50	SBS/SIS
TSRC, China	50	
Dynasol, Mexico	40	SBS
Sibur, Russia	30	SBS
Other U.S. producers	30	
Kraton, Brazil	30	SBS/SIS/SEBS
Kuraray, U.S.	20	SEBS/SEPS
Kuraray, Japan	20	SEBS/SEPS
Lanxess, Brazil	10	SBS/SEBS
Other Chinese companies	300	
Total	2,860	

Source: BCC Research

Styrenic Block Copolymers Technologies

The leading global SBC R&D players include Kraton, BASF and Japan Synthetic Rubbers.

SBC R&D currently focuses on:

- New initiating systems for lowering costs.
- Diversification and functional SBC performances.
- Low-pressure hydrogenation technologies.
- Radiation curing SBC technologies.
- Energy-saving technologies.
- Reversible addition-fragmentation chain transfer (RAFT) polymerization technology for making SBC with excellent heat resistance and solvent resistance.

Recent technological advances of SBC include:

- In 2014, Müller Kunststoffe, a subsidiary of the Sweden-based plastics producer Hexpol; and Akro Plastic, a PA producer, developed a low-density adhesion modified TPE, which is part of the Dryflex A family of compounds. The TPE has high stickiness and a specific gravity of less than one gram per square centimeter. This product is developed to deliver optimal adhesion to the Akromid Lite and Akromid XtraLite modified PA compounds in multi-component applications. Dryflex is a family of customized TPE solutions based on TPS (SBS and SEBS), TPO and TPV.

- In late 2013, S&E Specialty Polymers launched two new SEBS series: TufPrene 2200 and TufPrene 2000. They are TPE compounds that can be molded or extruded. They bond naturally to PE, PP, PA and ABS. The company is aiming these series at companies seeking a non-PVC alternative. Main applications include automotive trim, wire and cable, battery, footwear and window seals for building.

- Minnesota Wire, a company specializing in the custom design and production of cable assemblies for medical devices, selected Teknor Apex's TPE-S materials to replace its thermoplastic vulcanizate elastomers. Minnesota Wire replaced the TPVs that are standard in such applications with new styrenic thermoplastic elastomer compounds from Teknor Apex. Marketed under the Medalist MD-8421, MD-8431 and MD-8451 brand names, the TPE-S materials were created specifically for the medical market.

Global Thermoplastic Polyolefin Market

Thermoplastic polyolefin (TPO), also known as polyolefin elastomer (POE), is a blend of polyolefins and rubbers. The rubber contents usually are EPDM, NBR, IIR or natural rubber. Polyolefins are usually PP or PE. The most widely used TPO is blended by EPDM and PP.

Through the manufacturing method, TPO can be divided by reactor-made thermoplastic polyolefin (RTPO) and blended thermoplastic polyolefin (BTPO).

Most of the world's TPO elastomers are used for automotive purposes, including panels, buffer capsules, tubes, gear covers, sealing materials and interior materials. Other important applications include appliances, machinery, medical, architecture, and sports products.

Important TPO brands include Exact by ExxonMobil Chemical and Engage by Dow Chemical.

Estimates and forecasts for the global TPO market by application through 2019 are provided in the following table.

TABLE 39

GLOBAL THERMOPLASTIC POLYOLEFIN MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	568.2	587.1	790.3	6.1
Others	294.3	304.4	414.6	6.4
Total	862.5	891.4	1,204.9	6.2

Source: BCC Research

Global Thermoplastic Vulcanizate Market

Thermoplastic vulcanizate (TPV) can be recognized as a vulcanized and upgraded version of TPO. TPV has excellent elasticity and compression deformation resistance. It has environmental and aging resistance similar to EPDM. In addition, it has oil and solvent resistance similar to chloroprene rubber. Therefore, TPV is regarded as the more recyclable and environmentally friendly replacement to rubbers, especially to EPDM.

Most of the world’s TPV elastomers are currently used for automotive purposes, including sealing strips, tubes and interiors. In developed countries, an automobile may include four kilograms to five kilograms of TPV. In developing countries such as China and India, TPV consumption is usually less than two kilograms per vehicle.

Other important applications include appliances, medical, architecture and sports products.

Estimates and forecasts of the global TPV market and automotive application through 2019 are provided in the following table.

TABLE 40

GLOBAL THERMOPLASTIC VULCANIZATE MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	249.9	257.5	353.5	6.5
Others	130.0	134.4	184.2	6.5
Total	379.9	391.9	537.7	6.5

Source: BCC Research

Thermoplastic Vulcanizate Producers

Major TPV producers and developers include Teknor Apex (Sarlink), Advanced Elastomer Systems Limited (Santoprene, Vyram, Geolast), Dawn (Dawnprene), SK (Plastomer), ZEON (Zeotherm), DuPont (ETPV) and Down Corning (TPSiV).

AES's TPVs products include EPDM, NBR and NR types. Teknor Apex, Dawn and SK's TPVs are mainly EPDMs. ZEON and DuPont products are mainly ACMs. Down Corning's TPSiV is silicon rubber-based.

Global Thermoplastic Polyurethane Market

Thermoplastic polyurethane (TPU) is the first commercialized TPE. It usually consists of rigid blocks formed by diphenyl-methane-diisocyanate (MDI) or toluene diisocyanate (TDI) reacting with chain extenders and soft blocks formed by MDI or TDI reacting with high molecular polyols.

TPU has the advantages of high tensile strength, good toughness, abrasion resistance and oil resistance. Main applications include shoe materials, automobiles, tires, oil resistant hoses, medical products and waterproof membranes.

TPU can be processed by injection molding, extrusion and coating. Estimates and forecasts of the TPU market by processing method through 2019 are provided in the following table.

TABLE 41

GLOBAL THERMOPLASTIC POLYURETHANE MARKET BY PROCESSING METHOD, THROUGH 2019
(THOUSAND METRIC TONS)

Processing Method	2013	2014	2019	CAGR% 2014–2019
Injection molding	290.7	307.3	423.7	6.6
Extrusion	184.5	192.2	240.3	4.6
Adhesive	69.1	73.2	99.4	6.3
Coating	53.1	55.7	69.3	4.5
Total	597.4	628.4	832.7	5.8

Source: BCC Research

Estimates and forecasts of the TPU market by application through 2019 are provided in the following table.

TABLE 42

GLOBAL THERMOPLASTIC POLYURETHANE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Footwear	148.1	156.5	206.7	5.7
Engineering	138.3	145.6	192.5	5.7
Automotive	84.1	87.6	112.8	5.2
Adhesive	67.9	72.0	97.9	6.3
Others	158.9	166.7	222.8	6.0
Total	597.4	628.4	832.7	5.8

Source: BCC Research

Thermoplastic Polyurethane Producers

Taiwan, Europe and the U.S. are the main TPU manufacturing regions. China has also quickly expanded its TPU capacity in recent years.

There are more than 20 TPU manufacturers in Taiwan, with an annual capacity of more than 100,000 metric tons. Taiwanese TPU producers include Sunko Ink Co. Ltd., Coating Chemical Industry Co. Ltd. and Evermore Chemical Industry Co. Ltd.

China has TPU production facilities in Yantai, Baoding, Jinjiang and Nantong. China consumes nearly 40% of the global TPU output. China, however, maintains more than 40% of global TPU capacity.

Major TPU producers and developers include Bayer, Huntsman, Lubrizol, BASF, Wanhua and Sunko.

Important acquisitions in the TPU industry in recent years include:

- Noven was purchased by Lubrizol. Noven has a $1 billion TPU market.
- The Taiwan-based Ure-Tech Co was purchased by Bayer. Ure-Tech has a big share in the mainland China market.

China’s TPU capacity reached 360,000 metric tons in 2013, overtaking 40% of the global share, and it is still growing at a fast pace. It is estimated that China will soon account for half of the world’s TPU capacity.

Some of the expansion plans of China-based TPU facilities in the next two years include:

- Huntsmand Shanghai (www.huntsman.com) launched a new plant with an annual capacity of 21,000 metric tons of TPU in early 2014.

- Polyol is adding a capacity of 7,500 metric tons per year, which will be put into production in 2015.
- Baoding Bangtai plans to increase its total TPU capacity to 22,500 metric tons per year.
- Xuchuan Chemical plans to set up a TPU facility with an annual capacity of 20,000 metric tons.

It is therefore estimated that China's total TPU capacity will overtake 431,000 metric tons per year by 2016.

Thermoplastic Polyurethane Technologies

Modifying TPI or MDI can improve the performances of TPU. For example, 1,4-phenylene diisocyanate (PPDI) is a solidification agent for high-performance TPU. PPDI-TPU has much higher tensile strength and tearing strength compared to conventional TPU. When the temperature is greater than 120°C, the tensile strength and tearing strength of PPDI-TPU can remain at approximately nine MPa and 10 $kN*m^{-1}$, respectively, which have almost no difference from when it is at 50°C, several times higher than conventional TPUs whose performance drops significantly at high temperature. This means PPDI-TPU has much better thermal resistance than common TPUs.

Other important TPU R&D involves developing new types of dimethyl-biphenyl diisocyanate (TOPI) TPU and 1,5-naphthalene diisocyanate (NDI) TPU.

BASF developed a new TPU with special performance under the Infinergy brand name. It has low water absorption rate, meaning its volume increases less than 2% after 24 hours in water. In addition, this new product has excellent mechanical properties, abrasion resistance and chemical resistance.

Global Thermoplastic Polyester Elastomer Market

Thermoplastic polyester elastomer (TPEE) is a blend of polyester and polyether. At low-strain conditions, TPEE has higher modulus than most other TPEs. TPEE has much higher compression modulus and tensile modulus than its main TPU competitors. In addition, TPEE has excellent low-temperature notched impact strength, abrasion resistance and fatigue resistance.

These advantages allow TPEE to be used in environments that require high performance. Main applications include automotive, industrial products (e.g., hoses, belts) and appliances.

Estimates and forecasts of the TPEE market by application through 2019 are provided in the following table.

TABLE 43

GLOBAL THERMOPLASTIC POLYESTER ELASTOMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	163.8	172.4	225.0	5.5
Industry (e.g., hoses, belts)	72.7	76.5	97.8	5.0
Appliances	37.7	39.7	50.8	5.1
Others	22.8	24.0	31.0	5.3
Total	297.0	312.6	404.6	5.3

Source: BCC Research

Thermoplastic Polyester Elastomer Suppliers.

Major global TPEE producers and developers include DuPont, Lanxess (formerly DSM Elastomers) and LG. DuPont’s product is marketed under the brand name Hitler. LG’s TPEE brand is Key Flex.

Other Thermoplastic Elastomers

Other TPEs include TPA, TPVC and MPR.

Polyamide Thermoplastic Elastomer

Polyamide thermoplastic elastomer (TPA) is blend of polyamide and polyester or polyether. Like polyamide, TPA has high tensile and toughness, as well as good abrasion resistance. It is also resistant to oil and heat, and it has very good processability.

The polyamide segment of TPA could be nylon 6, nylon 66 or nylon 12.

Nylon-12 TPA is regarded as a high-end TPA. It has the potential be the most common commercialized TPA due to its excellent corrosion resistance and processability. It is usually used to replace fluoroelastomers (FKM and FEPM) and silicone rubber.

The low-end TPAs such as Nylon-6 TPA also have very good market potential. Nylon-6 TPA can be made at a lower cost than TPU, and it has processability similar to TPEE.

Major TPA applications include wire and cable sheath in automobiles or appliances, footwear, medical tubes and resins modification.

Polyvinyl Chloride-Based Thermoplastic Elastomer

Polyvinyl chloride-based thermoplastic elastomer (TPVC) can be designed to have different hardness by adjusting the uses of plasticizers. It has good coloring performance, and it is resistant to weathering, ozone, chemicals, scratching and heat. These advantages make it a good choice for sealing materials and wire and cable sheath for automobiles, appliances, industrial products, architecture, sports products and medical products, such as blood transfusion bags and tubes.

Melt Processable Rubber

Melt processable rubber (MPR) has excellent elasticity and is resistant to heat, oil and many chemicals. Its performance does not change significantly even after repeated processing. Its resistance to flame, weathering and ozone is better than most other TPEs.

Main applications of MPR include sealing strips, sealing pads, wire and cable sheath, footwear and gloves.

Chapter 5

EUROPEAN ELASTOMER MARKET

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 5
EUROPEAN ELASTOMER MARKET

This chapter describes the European elastomer market by breaking it down into segments at different levels.

- The elastomers market is broken down into two major segment: thermoplastic elastomers (TPEs) and thermoset elastomers (TSEs). Thermoset elastomers are those that irreversibly cure. On the contrary, thermoplastic elastomers are pliable or moldable above specific temperatures and return to solid state upon cooling.

- The TSE segment is further divided to three sub-segments: natural rubber (NR), synthetic rubbers (SRs) and recycled rubbers (RRs). Recycled rubber is also known as *reclaimed* rubber.

- The Synthetic Rubbers sub-segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, EPR and Others. The EPR section includes EPM and EPDM. The Others section is mostly comprised of saturated rubbers with relatively small volumes, including ethylene acrylate (AEM), fluoroelastomers (FKM), epichlorohydrin rubber (ECO), silicone rubber (e.g., fluorosilicone [FVMQ]), acrylic elastomer (ACM) and chlorosulfonated polyethylene (CSM).

- The TPE segment is further divided to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs with relatively small volumes of consumption, including TPA, TPVC and MPR.

- A TSE or TPE product may be further broken down into sections by sub-products.

Some segments, sub-segments and sections will be further divided or described by regions and applications. Capacities, technologies, industry trends and leading players will be also discussed.

The following table includes the estimates and forecasts of two major markets: TSEs and TPEs.

TABLE 44

EUROPEAN ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
Thermoset	4,789.0	4,855.8	5,181.4	1.3
Thermoplastic	919.8	9,37.7	1,077.9	2.8
Total	5,708.8	5,793.5	6,259.2	1.6

Source: BCC Research

TSE consumption will maintain stable growth in the next few years, whereas TPEs will experience stronger growth.

THERMOSET ELASTOMERS

Thermoset elastomers, also known as rubbers, include natural rubber (NR) and synthetic rubbers (SRs). In some countries, the term *synthetic rubber* also includes some types of thermoplastic elastomers, such as thermoplastic styrene elastomers (TPSs), also known as styrenic block copolymers (SBCs). But this report, however, excludes all thermoplastic elastomers from the Synthetic Rubbers and Rubbers Categories. As a result, SBCs are put into the Thermoplastic Elastomers category.

Recycled rubbers (RRs), also known as reclaimed rubbers, hold a significant market share in some countries. Consumption of RRs in Europe is small, but this report breaks the thermoset elastomers market down unto three segments: natural rubbers, synthetic rubbers and recycled rubbers.

Estimates and forecasts for the European rubber market through 2019 are provided in the following table.

TABLE 45

EUROPEAN THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
NR	1,380.0	1,380.0	1,350.0	-0.4
SRs	3,374.2	3,441.1	3,797.1	2.0
RRs	34.8	34.7	34.3	-0.2
Total	4,789.0	4,855.8	5,181.4	1.3

Source: BCC Research

Recycled rubbers include recycled natural rubber (RNR) and recycled synthetic rubber (RSR). The estimates and forecasts for the European recycled rubber market by product are shown in the following table.

TABLE 46

EUROPEAN RECYCLED RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs	27.5	27.4	27.1	-0.2
NR	7.3	7.3	7.2	-0.3
Total	34.8	34.7	34.3	-0.2

Source: BCC Research

According to experts, 3.0 metric tons of recycled natural rubber can be used to replace one metric ton of natural rubber, and 1.5 to 2.0 metric tons of recycled synthetic rubber can replace one metric ton of synthetic rubber. Therefore, this report assumes 3.0 metric tons of recycled natural rubber is one metric ton of natural rubber equivalent, and 1.75 metric tons of recycled synthetic rubbers are one metric ton of synthetic rubber equivalent. The numbers for recycled rubber volume in the previous table have been converted into *metric ton natural rubber equivalent* and *metric ton recycled rubber equivalent*.

If RNR is put into the NR segment and RSR is put into the SRs segment, the estimates and forecasts for the thermoset elastomer market will resemble those in the following table.

TABLE 47

EUROPEAN THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs*	3,401.7	3,468.5	3,824.2	2.0
NR*	1,387.3	1,387.3	1,357.2	-0.4
Total	4,789.0	4,855.8	5,181.4	1.3

*NR and SRs here include recycled rubber volume.

Source: BCC Research

Synthetic rubbers include IR, BR, SBR, NBR, CR, IIR, EPM/EPDM, ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

NATURAL RUBBERS

Natural Rubbers and Compounded Rubbers

In this report, the Natural Rubber segment includes natural rubber and compounded rubbers.

Natural rubber consists of polymers of organic compound isoprene with impurities of other organic compounds plus water. Commercial natural rubbers include standard rubber and ribbed smoked sheet (RSS).

Compounded rubbers usually consist of 95% to 99.5% natural rubbers, which are mostly polyisoprene, with additional chemicals such as stearic acid, styrene butadiene rubber, synthetic polyisoprene (IR), butadiene rubber (BR), carbon black, peptizers and nihil album. In this report, the volume of compounded rubber does not include additional chemicals.

Nearly 90% of the world's natural rubbers are produced in Southeast Asian countries such as Thailand, Malaysia, Indonesia and Vietnam. In 2013, the global natural rubber acreage was nearly 13.1 million hectares, with a total output of 12.4 million metric tons, up 3.8% from the previous year. Asia produced 11.4 million metric tons, maintaining 92% of the global production.

European Natural Rubber Consumption by Country

China, Europe, India, the U.S. and Japan are main natural rubber-consuming countries. Major natural rubber producers such as Indonesia, Thailand, Malaysia and Vietnam are also experiencing natural rubbers consumption, as the global industrial chain has moved some of the capacity of rubber products to these regions.

Estimates of European countries' natural rubber consumption are provided in the following table.

TABLE 48

EUROPEAN NATURAL RUBBER CONSUMPTION BY COUNTRY, 2013
(THOUSAND METRIC TONS/%)

Country	Consumption	Percent
Germany	210.0	15.2
France	190.0	13.8
Spain	170.0	12.3
Turkey	140.0	10.1
Italy	120.0	8.7
Poland	70.0	5.1
U.K.	60.0	4.3
Czech Republic	60.0	4.3

Russia	30.0	2.2
Other European countries	330.0	23.9
Total	1,380.0	99.9

Source: BCC Research

Germany, France and Spain consumed a large volume of natural rubber due to their relatively big tire industries.

Russia has developed synthetic rubbers to replace natural rubber for more than half a century since the former Soviet Union era. It therefore consumed a very small volume of natural rubber.

SYNTHETIC RUBBERS

Synthetic rubbers are thermoset elastomers mainly produced from petroleum byproducts. This segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, ERP and Others. The ERP section includes EPM and EPDM. The Others section is comprised mostly of saturated rubbers that have relatively small volumes, including ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

Estimates and forecasts of the European synthetic rubber market are provided in the following table.

TABLE 49

EUROPEAN SYNTHETIC RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SBR	1,114.0	1,128.0	1,212.2	1.5
BR	718.0	738.0	846.8	2.8
IR	389.0	398.1	446.7	2.3
EPR	375.0	382.1	419.8	1.9
IIR	314.0	319.7	349.5	1.8
NBR	138.0	139.5	148.2	1.2
CR	75.0	75.4	77.3	0.5
Others	251.2	260.3	296.6	2.6
Total	3,374.2	3,441.1	3,797.1	2.0

Source: BCC Research

SBR will remain the largest segment in the following five years, but its market share will decline.

European Styrene Butadiene Rubber Market

Styrene butadiene rubber (SBR) is a copolymer of styrene and butadiene. It comprises the world's largest synthetic rubber family. Major types include emulsion-polymerized styrene butadiene rubber (ESBR) and solution polymerized styrene butadiene rubber (SSBR).

Estimates and forecasts of European SBR consumption by major types through 2019 are provided in the following table.

TABLE 50

EUROPEAN STYRENE BUTADIENE RUBBER MARKET BY TYPE, THROUGH 2019 (THOUSAND METRIC TONS)

Type	2013	2014	2019	CAGR% 2014–2019
ESBR	804.0	801.6	789.6	-0.3
SSBR	310.0	326.4	422.6	5.3
Total	1,114.0	1,128.0	1,212.2	1.5

Source: BCC Research

ESBR will continue to maintain most of the market share, but SSBR will see a much faster growth.

In Europe, oil-extended ESBR accounts for nearly two-thirds of total ESBR consumption. Oil-extended ESBR has lower heat generation, better processability and better flex resistance compared to non-oil extended version. When used for tread, oil-extended ESBR has better traction performance and abrasion resistance. Oil-extended ESBR is mostly used for making tire treads and side walls.

Major SBR applications include tires, automotive components, conveyer belts, hoses, tapes, footwear, medical products and modifiers.

Most SBR is used for tire manufacturing. Estimates and forecasts of European SBR consumption by application through 2019 are provided in the following table.

TABLE 51

EUROPEAN STYRENE BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	724.1	733.2	788.0	1.5
Automotive	43.0	42.8	46.2	1.5
Others	346.9	352.0	378	1.4
Total	1,114.0	1,128.0	1,212.2	1.5

Source: BCC Research

In tire application, SBR is mostly used for treads, side walls and carcasses. SBR is widely used for tires in passenger cars, tractors and motorcycles. It is rarely used for heavy-duty tires.

In automotive applications, SBR is used for making hoses, V-belts, synchronous belts, O rings, sealing strips and shock-reducing rubber.

Other applications include footwear, conveyer belts, hoses, tapes, medical products and modifiers.

Styrene Butadiene Rubber Producers

- *Emulsion-Polymerized Styrene Butadiene Rubber Producers*

Leading global ESBR manufacturers include China National Petroleum Corporation (CNPC), Kumho Tires and Sinopec. These three companies produce nearly one-third of the world’s capacity.

Capacities of leading European ESBR manufacturers and their market shares are provided in the following table.

TABLE 52

LEADING EUROPEAN EMULSION-POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS/%)

Company	Capacity	Percent
Polimeri (Eni), Italy, U.K.	190	18.3
Carom, Romania	130	12.5
Dwory, Poland	110	10.6

Kaucuk, Czech Republic	80	7.7
Lukoil, Bulgaria	80	7.7
Lanxess, France	80	7.7
Others	370	35.6
World total	1,040	100.0

Source: BCC Research

- *Solution Polymerized Styrene Butadiene Rubber Producers*

Leading SSBR manufacturers include Styron, Firestone, Michelin, Japan Synthetic Rubber and Goodyear. These four companies produce more than 40% of the world's capacity. Firestone was purchased by Bridgestone and now is part of Bridgestone.

Capacities of leading European SSBR manufacturers and their market shares are provided in the following table.

TABLE 53

LEADING EUROPEAN SOLUTION POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity	Products
Styron, Germany	160	SSBR
Michelin, France	50	SSBR/BR
Voronezh Russia	40	SSBR
Bayer, France	30	SSBR/BR
Dynasol, Spain	30	SSBR/SBS
EniChem, U.K.	30	SSBR/SBS
Altofina, Belgium	30	SSBR/SBS
Others	40	SSBR
Total	410	

Source: BCC Research

Styrene Butadiene Rubber Technologies

Leading global players in SBR R&D include Goodyear, Bridgestone, Japan Synthetic Rubber Co. Inc., BASF, Dow Chemical and ZEON. They license their manufacturing technologies and patents to manufacturers in Asia, South America and Africa.

Technological trends of emulsion-polymerized styrene butadiene rubber include:

- Higher monomer conversion percentage.

- New functional monomers for improving rubber performance.
- New types of emulsifiers and conditioning agents.
- Environmentally friendly termination agents.
- Powder manufacturing method.

For SSBR production, most manufacturers use technologies based on the Phillips' batch polymerization method. Other use continuous polymerization processes based on the Firestone method. Firestone is now part of Bridgestone.

Technological innovations of SSBR mainly focus on microstructure control. An example is developing a functional SSBR with high ethylene content and moderate and controllable styrene content by using new types of multifunctional initiators, couplers and conditioning agents.

European Butadiene Rubber Market

Butadiene rubber (BR) is an elastomer polymerized by 1,3-butadiene monomers, which is a conjugated diene with the formula C_4H_6.

BR is mostly used for making tires. It is also used as an impact-resistance modifier in making high impact polystyrene (HIPS) and acrylonitrile butadiene styrene (ABS).

Estimates and forecasts of European BR consumption by major applications through 2019 are provided in the following table.

TABLE 54

EUROPEAN BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	475.3	488.5	564.4	2.9
HIPS	90.5	93.0	106.3	2.7
ABS	25.4	26.1	29.5	2.5
Others	126.8	130.4	146.6	2.4
Total	718.0	738.0	846.8	2.8

Source: BCC Research

In tire applications, BR is mostly used for making treads and side walls. Nd-BR is a promising type due to its advantages, including high tensile strength, low heat generation, low hysteresis loss, excellent flex resistance and wet traction, and low rolling resistance.

As an impact resistance modifier for HIPS, the additive BR equals 5% to 8% of HIPS in terms of volume.

As a modifier for making ABS, one kilograms ABS is added with 0.1 kilograms to 0.2 kilograms BR.

BR is also used for making hoses, belts, sports products, automotive parts and other products.

Western Europe consumes more than eastern and middle Europe (e.g., former Soviet states, Russia), but the latter will grow faster in the next five years.

Estimates and forecasts for western European BR consumption by major applications through 2019 are provided in the following table.

TABLE 55

WESTERN EUROPEAN BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	307.2	314.6	356.9	2.6
HIPS	59.1	60.5	67.9	2.3
ABS	16.9	17.3	19.2	2.1
Others	85.8	87.9	96.8	1.9
Total	469.0	480.3	540.7	2.4

Source: BCC Research

Estimates and forecasts of east and middle European BR consumption by major applications through 2019 are provided in the following table.

TABLE 56

EAST AND MIDDLE EUROPEAN BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	168.1	174.0	207.5	3.6
HIPS	31.4	32.5	38.4	3.4
ABS	8.5	8.8	10.3	3.2
Others	41.1	42.5	49.9	3.3
Total	249.0	257.7	306.1	3.5

Source: BCC Research

Butadiene Rubber Producers

Major BR producers include Sinopec, Lanxess, Kumho, Michelin, Goodyear, UBE, Eni, CNPC and Sibur.

Butadiene Rubber Technologies

The leading global players in BR R&D include UBE, Goodyear, Bridgestone, Japan Synthetic Rubber and Lanxess. They develop different series of BR. Important R&D trends include:

- *Ti-BR:* The only large Ti-BR producer is the Russia-based Sibur. This technology could be phased out in the future.
- *Co-BR:* Technological innovations focus on making syndiotactic 1,2 polybutadiene with different crystallinity and melting temperatures.
- *Ni-BR:* The focus is on high cis-hyperbranched BR.
- *Li-BR:* The focus is developing low-cis BR (LCBR) with different ethylene content.
- *Nd-BR:* The focuses include advanced initiating systems and related polymerization processes, as well as chain-end modification technologies.
- *Others:* Other important trends include making high ethylene content BR by using Mo or Fe initiating systems.

European Nitrile Rubber Market

Nitrile rubber, also known as acrylonitrile butadiene rubber, Buna-N and Perbunan, is a copolymer of acrylonitrile (ACN) and butadiene. The main types include hydrogenated nitrile rubber (HNBR), powder nitrile rubbers (PNBR) and carboxylated nitrile rubber (XNBR).

Estimates and forecasts of European NBR consumption by product through 2019 are provided in the following table.

TABLE 57

EUROPEAN NITRILE RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
PNBR	38.6	39.1	42.0	1.4
HNBR	16.7	16.7	19.3	2.9
Others	82.7	83.9	87.0	0.8
Total	138.0	139.7	148.2	1.2

Source: BCC Research

Major NBR products include hoses, belts, wire and cable, O rings, adhesives, sealants, footwear and molded products. Many of these products are used in automobiles.

More than 60% of European HNBR is used for automotive purposes. Estimates and forecasts of European HNBR consumption and automotive applications through 2019 are provided in the following table.

TABLE 58

EUROPEAN HYDROGENATED NITRILE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	10.7	10.7	12.4	3.0
Others	6.0	6.0	6.9	2.8
Total	16.7	16.7	19.3	2.9

Source: BCC Research

In Europe, an automobile usually consumes 0.5 kilograms to 0.6 kilograms of HNBR.

Nitrile Rubber Producers

The leading global players of NBR production and R&D include Lanxess, ZEON, Bayer, Sinopec, Sibur, JSR and Polimeri. ZEON NBR’s trade name is Nipol, and Lanxess’ NBR is marketed under the trade name Krynac.

Leading European NBR producers and their capacities are shown in the following table.

TABLE 59

LEADING EUROPEAN NITRILE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013
(THOUSAND METRIC TONS)

Company	Capacity
Lanxess, France	85
Sibur, Russia	41
Polimeri, Italy	33
ZEON, U.K.	15
Others	23
Total	197

Source: BCC Research

Lanxess produces nearly half of the NBR in Europe. Sibur produces NBR in its two plants in Russia.

Nitrile Rubber Technologies

The leading global players of NBR R&D include Lanxess, Bayer, ZEON and Eni.

Major R&D advances for NBR include polymerization formula, polymerization methods, automatic control technologies and new grades of products.

The focuses of improved polymerization formulas are high efficiency and environmentally friendly formulas.

New products are specialized and differentiated NBR for different applications. They include chain-end NBR, carboxylated nitrile rubber (XNBR), fast-vulcanized NBR, hydrogenate NBR (HNBR), third monomer-copolymerized NBR and powder NBR.

European Isobutylene Isoprene Rubber Market

Isobutylene isoprene rubber, also known as butyl rubber, is a copolymer of isobutylene and isoprene. IIR has excellent impermeability and good flex properties. Its air permeability is only one-seventh of natural rubber and one-fifth of styrene butadiene rubber. Its steam permeability is only 1/200 of natural rubber and 1/140 of styrene butadiene rubber.

Most IIRs are halogenated. The halogenated IIRs (HIIRs) include chloro isobutylene isoprene rubber (CIIR) and bromo isobutylene isoprene rubber (BIIR).

Estimates and forecasts of European IIR and HIIR consumption through 2019 are provided in the following table.

TABLE 60

EUROPEAN ISOBUTYLENE ISOPRENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
HIIR	235.5	239.7	262.8	1.9
Others	78.5	79.9	86.7	1.6
Total	314.0	319.7	349.5	1.8

Source: BCC Research

Major IIR products include tires, electric insulation materials, medical bottle plugs, gas mask and sealing materials.

Less than two-thirds of European HIIR is used for tire purposes. Estimates and forecasts of European HIIR consumption and automotive applications through 2019 are provided in the following table.

TABLE 61

EUROPEAN HALOGENATED ISOBUTYLENE ISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	151.6	153.7	169.9	2.0
Others	83.9	86.0	92.9	1.6
Total	235.5	239.7	262.8	1.9

Source: BCC Research

In tire applications, IIR is mostly used for making inner liners and inner tubes.

Isobutylene Isoprene Rubber Producers

Exxon Mobil and Lanxess are the world’s two largest IIR producers. Exxon Mobil produces nearly half of the world’s capacity with its subsidiaries and joint ventures.

Leading European IIR manufacturers and their capacities are stated in the following table.

TABLE 62

LEADING EUROPEAN ISOBUTYLENE ISOPRENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity
Lanxess, Belgium	150
Exxon Mobil, U.K.	110
Nizhnekamsk, Russia	100
Socabu, France	70
Togliattikauchub, Russia	60
Pitesti, Romania	5
Total	495

Source: BCC Research

ExxonMobil and Lanxess together maintain more than half of European IIR capacity.

ExxonMobil has a capacity of approximately 110,000 metric tons of IIR at Fawley, U.K. In the U.S., ExxonMobil has two plants, with a total capacity of approximately 290,000 metric tons of IIR per year.

Lanxess is the world's largest IIR producer. It has three plants. In 2012, it expanded the production capacity of its plant in Zwijndrecht, Belgium by 10% to 150,000 metric tons per year.

Lanxess' other two plants are in Singapore and Canada. In 2013, it launched a new IIR plant in Jurong Island, Singapore, with a total capacity of 100,000 metric tons per year. Lanxess has another IIR plant in Sarnia, Canada, with a capacity of 150,000, metric tons per year.

Russian companies maintain another major share of European IIR capacity.

Isobutylene Isoprene Rubber Technologies

The leading global players for IIR R&D include Exxon Mobil, Lanxess and Bayer.

IIR R&D mainly focuses on advanced initiating systems, high polymerization temperatures, improved reactors and new product development.

European Ethylene Propylene Rubber Market

Ethylene propylene rubber includes ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM). EPR is resistant to heat, oxidation, ozone, steam, chemicals and weathering. It can be used at temperatures from -55°C to 150°C. At 120°C it can also be used for long periods. Above 120°C, the aging of EPR could be accelerated, and the service life will be shortened. EPR can be used under even worse conditions by oxide crosslinking.

EPR has excellent electrical insulation properties. It has low density (0.87) and can be filled with oil and other materials to lower costs. For high-Mooney viscosity EPR, filling with other materials does not reduce EPR's mechanical properties to a significant degree.

The disadvantages of EPR include poor oil resistance and long cure time, which is three- to four-times longer than most of other synthetic rubbers. In addition, EPR has low adhesiveness to itself and other materials, which makes it difficult to be processed.

Estimates and forecasts of European EPR consumption by product through 2019 are provided in the following table.

TABLE 63

EUROPEAN ETHYLENE PROPYLENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
EPDM	333.8	340.1	374.1	1.9
EPM	41.3	42.0	45.8	1.7
Total	375.0	382.1	419.8	1.9

Source: BCC Research

EPR is used for automotive components, blend modification, architecture, wire and cable, and tires. Estimates and forecasts of European EPR consumption by application through 2019 are provided in the following table.

TABLE 64

EUROPEAN ETHYLENE PROPYLENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	163.3	162.8	178	1.8
Architecture	45.0	45.9	50.4	1.9
Blend modifications	41.3	42.0	44.1	1.0
Wire and cable	28.1	28.7	31.3	1.7
Tires	5.3	5.3	5.9	2.2
Others	92.0	97.4	110.1	2.5
Total	375.0	382.1	419.8	1.9

Source: BCC Research

EPR is the most widely-used automotive rubber (except for tire applications). It is also used for making sealing strips for automotive doors and windows, ventilation pipes for air conditioners, seal components and hoses.

In blend modification applications, EPR is used to improve other rubbers or polymers' resistance to heat, oxidation, ozone, steam and low temperatures.

In architectural application, EPR is used for waterproof rolls, sealing strips and sports tracks.

Ethylene Propylene Rubber Producers

Major global EPR producers include Exxon Mobil, Mistsui Chemicals, Lanxess, Dow Chemical, Crompton, DuPont, Herdillia, Kumho, Mitsui Chemicals, Versalis (former Polimeri Europa) and Sumitomo Chemical. In Europe, Lanxess dominates the market with the former DSM EPR facilities.

Capacities and brand names of major European manufacturers are shown in the following table.

TABLE 65

LEADING EUROPEAN ETHYLENE PROPYLENE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013
(MILLION METRIC TONS)

Company	Location	Capacity	Trade Name	Method
Lanxess (DSM)	Geleen, The Netherlands	160	Keltan	Solution
Exxon Mobil France	France	85	Vistalon	Solution
Polimeri Europa (Eni)	Ferrara, Italy	85	Dutral	Suspension
Lanxess Germany	Marl, Germany	70	Buna AP	Solution
Nizhnekamskneftekhim	Russia	30	Elastokam	Solution
Total		430		

Source: BCC Research

After acquiring DSM, Lanxess become the largest EPR supplier in Europe. Polimeri Europa, a subsidiary of Eni, changed its name to Versalis in 2011.

Ethylene Propylene Rubber Technologies Research and Development

The world's leading players for EPR R&D include Exxon Mobil, Lanxess, Mistsui Chemicals and Bayer. Solution polymerization method dominates the global EPR production.

EPR R&D mainly focuses on advanced initiating systems and polarization modification.

- The initiating systems have moved from V and Ti systems of Ziegler-Natta series to metallocene and low-valence homogeneous systems.
- Polarization modification is usually used for improving EPR's compatibility to other rubbers and materials. Examples include chloration, sulfonation and blending modifications with organic silicon and nylon.

European Polyisoprene Rubber Markets

Polyisoprene rubber (IR) is a synthetic rubber having similar properties to natural rubber, so in some countries it was called *synthetic natural rubber*. It has better water resistance and electrical insulation than natural rubber. The strength, adhesiveness and

processability of raw rubber and tearing strength and fatigue resistance of cured rubber are usually slightly lower than natural rubber.

Estimates and forecasts of European IR consumption by application through 2019 are provided in the following table.

TABLE 66

EUROPEAN POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	309.0	316.3	355.0	2.3
Machinery	54.0	55.3	62.2	2.4
Footwear	4.3	4.4	4.7	1.3
Adhesives and sealants	10.6	10.8	11.9	2.0
Others	11.1	11.3	12.9	2.5
Total	389.0	398.1	446.7	2.3

Source: BCC Research

For tire applications, IR is used in treads, side walls, carcasses, inner liners, belt plies and tire shoulders.

Eastern and middle European countries consume much more IR than west European countries.

Estimates and forecasts of west European IR consumption by application through 2019 are provided in the following table.

TABLE 67

WEST EUROPEAN POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	44.4	45.1	48.5	1.5
Machinery	14.7	15.0	16.2	1.6
Adhesives and sealants	6.8	6.9	7.5	1.7
Footwear	1.1	1.1	1.2	1.8
Others	7.0	7.1	8.0	2.4
Total	74.0	75.2	81.4	1.6

Source: BCC Research

Estimates and forecasts of European IR consumption by application through 2019 are provided in the following table.

TABLE 68

EAST AND MIDDLE EUROPEAN POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	264.5	271.2	306.5	2.5
Machinery	39.4	40.4	46.0	2.6
Footwear	3.2	3.2	3.5	1.8
Adhesives and sealants	3.8	3.9	4.4	2.4
Others	4.1	4.2	4.9	3.1
Total	315.0	322.9	365.3	2.5

Source: BCC Research

More than 80% of IR in this region is consumed by Russia. For decades, Russia (the former Soviet Union) has been actively developing IR for its tire industry.

Synthetic Polyisoprene Producers

Major global IR producers include NKNH, Sibur (Togliattikauchuk), Goodyear and Sinopec.

Leading European producers and their capacities are provided in the following table.

TABLE 69

LEADING EUROPEAN SYNTHETIC POLYISOPRENE MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity
NKNH	200
Kauchuk Sterlitamak	100
Togliattikauchuk	60
Kraton, The Netherlands	25
Total	385

Source: BCC Research

Togliattikauchuk is a subsidiary of Sibur. For decades, Russia (and the former Soviet Union) has been actively developing IR for its tire industry. Russia once accounted for more than

half of the world's IR capacity and consumption. Nizhnekamskneftekhim (NKNH) is the world's largest IR supplier, with an annual capacity of 200,000 metric tons. Russia still maintains more than 45% of the global capacity despite a challenge for supremacy from the fast-growing Chinese capacity.

Synthetic Polyisoprene Technologies

The leading global IR R&D players include Goodyear, Bayer, Japan Synthetic Rubber and Kuraray.

Technological trends of IR include:

- *Li-IR:* Cis contents could be increased by introducing active components into lithium initiator. Cis content is increased to more than 98% by using n-BuLi with 1, 3-dibromobenzene and triphenylamine
- *Ti-IR:* The most popular initiator could be Ti-based initiators. An example is $TiCl_4$-AIR_3 initiator, which could be added with synergistic-effect third component for improving system activity. Chinese companies use Ti-based initiators to produce Trans-1, 4 polyisoprene (TPI), which has been successfully used for replacing natural rubbers in heavy-duty tires.
- *Nd-IR:* Many companies engage in the innovation and optimization of Nd-based initiating system and polymerization process.

European Chloroprene Rubber Markets

Chloroprene rubber, also known as polychloroprene or Neoprene, the trade name given by DuPont, is a synthetic rubber produced through the polymerization of chloroprene. It has good chemical stability and maintains flexibility over a wide temperature range. CR has good mechanical properties and is resistant to oil, heat, flame, sunlight, ozone, acid, alkali and chemicals.

The disadvantages of CR include relatively bad low-temperature resistance and poor electrical insulation. In addition, CR has low storage stability. The so-called *bin cure* occurs in the storage of raw CR rubber, which increases Mooney viscosity and makes the rubber harder.

Major CR applications include adhesives for footwear and architecture, industrial products (e.g., hoses and belts, sealing strips and pads, white-wall tires, cycle tires), and wire and cable.

Estimates and forecasts of the European CR market by application are provided in the following table.

TABLE 70

EUROPEAN CHLOROPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Industrial products	50.2	50.5	52.1	0.6
Wire and cable	12.8	12.8	13.2	0.6
Adhesives	12.0	12.1	12.0	-0.2
Total	75.0	75.4	77.3	0.5

Source: BCC Research

Chloroprene Rubber Producers

Major global CR producers include Denka, DuPont and Lanxess. Global CR capacity reached historical height of 800,000 metric tons in the 1980s. From the early 1990s to mid-2000s, however, CR was gradually replaced by EPR and other rubbers, especially in automotive applications, and capacity dropped significantly. After 2005, CR demands from Asia (especially China) re-grew due to the booming automobile and real estate markets there. It’s estimated that global CR capacity will continue slow growth in the following five years.

Leading European CR manufacturers and their capacities can be found in the following table.

TABLE 71

LEADING EUROPEAN CHLOROPRENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity
Lanxess, Germany	63.0
Nairit, Armenia	34.0
Total	97.0

Source: BCC Research

In July 2014, Lanxess completed an expansion of its Baypren solid CR production operation in Dormagen, Germany, increasing the annual capacity of solid CR by 10% to 63,000 metric tons.

Nairit plant is one of the oldest chemicals production facilities in Armenia, with a history of more than 75 years.

Eni, another big European player, closed its CR production facility in the mid-2000s, which caused the shortage of global CR supplies.

Chloroprene Rubber Technologies

The leading global players for CR R&D include Denka, DuPont, Bayer and Lanxess.

The raw materials of CR are toxic and cause considerable damage to the environment, so CR has higher environmental costs than most other synthetic rubbers. In addition, the manufacturing process is relatively long and costly, so CR has been gradually replaced by other rubbers.

CR is still widely used in adhesives. R&D for CR currently focuses on graft modification of solvent-type CR. Graft modification improves the bonding ability between CR and some types of advanced materials. Powder technology is another direction for CR innovations.

European Markets for Other Synthetic Rubbers

Other important synthetic rubbers include ECO, AEM, FKM, silicone rubber (SIR) and ACM. In this report, silicone rubber includes fluorosilicone rubber (FVMQ).

In Europe, nearly one-third of these rubbers are used for automotive purposes (except for tire application). Estimates and forecasts of some of these rubbers used for automotive purposes are provided in the following table.

TABLE 72

EUROPEAN OTHER SYNTHETIC RUBBERS FOR AUTOMOTIVE APPLICATIONS BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
FKM	25.8	25.7	29.3	2.7
SIR	17.2	17.1	20.2	3.4
ECO	15.0	14.9	18.0	3.9
ACM	8.6	8.5	11.2	5.7
AEM	6.4	6.4	9.0	7.1
Total	73.0	72.6	87.7	3.9

Source: BCC Research

Fluorocarbon Rubber

Fluorocarbon (FKM) is resistant to high temperatures, ozone, oxygen, oil and many other chemicals. Under dynamic conditions, the lowest service temperature is approximately

15°C (5°F). Gas permeability is very low and similar to that of butyl rubber. Special FKM compounds exhibit an improved resistance to acids and fuels.

Globally, nearly 60% of FKM is used for the automotive industry. Major applications include fuel hoses, gas pipes, fuel pump and jet device seals, valve stem seals, dynamic seals, piston seals, crankshaft oil seals, universal joint gaskets, O rings, and air conditioning compressor seals. An automobile could use 0.2 kilograms to 1.6 kilograms of FKM.

Epichlorohydrin Rubber

Epichlorohydrin (ECO) is copolymer or homopolymer with similar properties to nitrile rubber, but with better oil and heat resistance. It has a low gas permeability and better low temperature flexibility than NBR. It is resistant to acids, alkalis and ozone. Disadvantages of ECO include poor compression set and corrosive effect on metals.

ECO was first developed by two U.S. companies—Goodrich and Hercules—in 1960s. Goodrich produced ECO under the trade name Hydrin, and Hercules produced it under the trade name Herclor. ZEON entered the ECO industry in the 1970s under an agreement with Hercules and another Japanese company. Hydrin currently belongs to ZEON.

ZEON’s Hydrin polymers are used for fuel oil-resistant applications for automobile gaskets, hoses and diaphragms, as well as printer rolls and anti-static applications.

Fluorosilicone Rubber

Fluorosilicone rubber (FVMQ) contains trifluoropropyl groups next to the methyl groups. The mechanical and physical properties are similar to VMQ. FVMQ, however, offers improved fuel and mineral oil resistance, but poor hot air resistance when compared with silicone rubber (VMQ).

THERMOPLASTIC ELASTOMERS

TPEs include SBC (also known as TPS), TPO, TPV, TPEE, TPU, TPA, TPVC and MPR.

ADVANTAGES AND MARKET DRIVERS

In many applications, TPEs are advanced and better choices than TSEs.

- TPEs have simpler manufacturing methods for making end products. For example, making automobile rubber seal strips from ethylene propylene diene monomer (EPDM) requires three steps: mixed compounding, molding and high-temperature vulcanization. Making the product from TPE only requires a direct molding step. Simpler manufacturing methods largely increase production efficiency.

- Second, TPE saves energy. Processing $1,000 worth of synthetic rubber usually consumes more than one metric tons of standard coal equivalent.

According to an automotive manufacturer, the three steps for making one kilogram of automobile rubber seal strips of EPDM could consume 2.2 kilowatts to 2.3 kilowatts. The single molding step for making automobile rubber seal strips from TPE usually consumes no more than 0.6 kilowatts per kilogram. The TPE route reduces energy consumption by nearly 75%. Likewise, compared to making automobile dustproof covers from chloroprene rubber (CR), the TPE route could reduce energy consumption by 70% to 80%. Europe actively leads the world's efforts toward reducing greenhouse gases to tackle climate change problems, so the energy-saving benefit will be a strong momentum for TPEs in this market.

- TPE is recyclable. More than 20 million metric tons of waste rubber are produced per year globally. TPE is more recyclable than synthetic rubbers making it an environmentally friendly choice.

THERMOPLASTIC ELASTOMERS PROUCTS

This report divides the TPE market into six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment includes TPEs that have relatively small volumes of consumption, including TPA, TPVC and MPR.

European Styrenic Block Copolymer Market

Styrenic block copolymer (SBC) is the most widely-used thermoplastic elastomer. Major types of SBC include SBS, SEBS, SIS and SEPS.

Hydrogenated SBCs, including styrene ethylene butylene styrene (SEBS) and styrene ethylene propylene styrene (SEPS), are relatively new SBC types. They have advantages such as better aging resistance and tensile properties than un-hydrogenated SBCs.

Major applications include adhesives and sealants, asphalt modifiers, polymer modifiers, viscosity index (VI) improver and footwear.

Estimates and forecasts of the European SBC market by application are presented in the following table.

TABLE 73

EUROPEAN STYRENIC BLOCK COPOLYMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Asphalt modifiers	139.0	142.5	162.8	2.7
Footwear	61.0	62.5	69.6	2.2
Adhesives and sealants	54.2	55.6	63.7	2.8
Polymer modifiers	33.9	34.7	38.5	2.1

Viscosity index improvers	3.4	3.5	4.0	2.7
Others	47.5	48.6	54.6	2.4
Total	339.0	347.4	393.2	2.5

Source: BCC Research

Styrenic Block Copolymers Producers

Major global SBC producers include Sinopec, Kraton and LCY Group.

Important facilities and their capacities in Europe are provided in the following table.

TABLE 74

LEADING EUROPEAN STYRENIC BLOCK COPOLYMER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity	Product
Dynasol, Spain	110.0	SBS/SEBS
Kraton, Germany	100.0	SBS
Eni (Polimeri), Italy	90.0	SBS/SIS/SEBS
Kraton, France	90.0	SBS/SIS/SEBS
Sibur, Russia	30.0	SBS
Other European producers	50.0	
Total	470.0	

Source: BCC Research

Styrenic Block Copolymer Technologies

The leading global players for SBC R&D include Kraton, BASF and Japan Synthetic Rubbers.

SBC R&D currently focuses on:

- New initiating systems for lowering costs.
- Diversification and functional SBC performances.
- Low-pressure hydrogenation technologies.
- Radiation SBC curing technologies.
- Energy-saving technologies.
- Reversible addition-fragmentation chain transfer (RAFT) polymerization technology for making SBC with excellent heat resistance and solvent resistance.

European Thermoplastic Polyolefin Market

Thermoplastic polyolefin (TPO), also known as polyolefin elastomer (POE), is a blend of polyolefins and rubbers. The rubber contents are usually EPDM, NBR, IIR or natural rubber. The polyolefins are usually PP or PE. The most widely used TPO is blended by EPDM and PP.

Through the manufacturing method, TPO can be divided by reactor-made thermoplastic polyolefin (RTPO) and blended thermoplastic polyolefin (BTPO).

Most of the world's TPO elastomers are used for automotive purposes, including panels, buffer capsules, tubes, gear covers, sealing materials and interior materials. Other important applications include appliances, machinery, medical, architecture and sports products.

Important TPO brands include Exact by ExxonMobil Chemical and Engage by Dow Chemical.

Estimates and forecasts of European TPO market and automotive application through 2019 are provided in the following table.

TABLE 75

EUROPEAN THERMOPLASTIC POLYOLEFIN MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	124.6	124.0	138.0	2.2
Other	64.2	63.9	74.3	3.1
Total	188.8	187.9	212.4	2.5

Source: BCC Research

European Thermoplastic Vulcanizate Market

Thermoplastic vulcanizate (TPV) can be taken as a vulcanized and upgraded version of TPO. TPV has excellent elasticity and compression deformation resistance. It has environmental and aging resistance similar to EPDM. In addition, it has oil and solvent resistance similar to chloroprene rubber. TPV is therefore regarded as the more recyclable and environmentally friendly replacement to rubber, especially to EPDM.

Most of the world's TPV elastomers are currently used for automotive purposes, including sealing strips, tubes and interiors. In developed countries, an automobile could contain four kilograms to five kilograms of TPV. In developing countries such as China and India, TPV consumption is usually less than two kilograms per vehicle.

Other important applications include appliances, medical, architecture and sports products.

Estimates and forecasts of the European TPV market and automotive applications through 2019 are provided in the following table.

TABLE 76

EUROPEAN THERMOPLASTIC VULCANIZATE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	64.5	64.2	73.8	2.8
Other	29.0	28.8	32.4	2.4
Total	93.5	93.0	106.2	2.7

Source: BCC Research

Thermoplastic Vulcanizate Producers

Major TPV producers and developers include Teknor Apex (Sarlink), Advanced Elastomer Systems Limited (Santoprene, Vyram, Geolast), Dawn (Dawnprene), SK (Plastomer), ZEON (Zeotherm), DuPont (ETPV) and Down Corning (TPSiV).

AES's TPVs products include EPDM, NBR and NR types. Teknor Apex, Dawn and SK's TPVs are mainly EPDM types. ZEON and DuPont products are mainly ACM types. Down Corning's TPSiV is silicon rubber-based.

European Thermoplastic Polyurethane Market

Thermoplastic polyurethane (TPU) is the first commercialized TPE. It usually consists of rigid blocks formed by diphenyl-methane-diisocyanate (MDI) or toluene diisocyanate (TDI) reacting with chain extenders and soft blocks formed by MDI or TDI reacting with high molecular polyols.

TPU has the advantages of high tensile strength, toughness, abrasion resistance and oil resistance. Major applications include shoe materials, automobiles, tires, oil resistant hoses, medical products and waterproof membranes.

TPU can be processed by injection molding, extrusion and coating. Estimates and forecasts of the TPU market by processing method through 2019 are provided in the following table.

TABLE 77

EUROPEAN THERMOPLASTIC POLYURETHANE MARKET BY PROCESSING METHOD, THROUGH 2019
(THOUSAND METRIC TONS)

Processing Method	2013	2014	2019	CAGR% 2014–2019
Injection molding	55.1	56.1	62.4	2.2
Extrusion	45.3	45.8	48.8	1.3
Coating	8.9	9.1	10.0	1.9
Adhesive	7.4	7.5	7.8	0.8
Total	116.7	118.5	129.0	1.7

Source: BCC Research

Major TPU applications include shoes materials, automobiles, engineering, tires, oil-resistant hoses, medical products and waterproof membranes.

Estimates and forecasts of the TPU market by application through 2019 are provided in the following table.

TABLE 78

EUROPEAN THERMOPLASTIC POLYURETHANE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Engineering	26.5	26.9	29.3	1.7
Automotive	21.5	21.9	23.7	1.6
Footwear	18.2	18.2	18.0	-0.2
Adhesives	7.4	7.5	7.8	0.8
Others	43.1	44.0	50.2	2.7
Total	116.7	118.5	129.0	1.7

Source: BCC Research

Thermoplastic Polyurethane Producers

Taiwan, Europe and the U.S. are major TPU manufacturing regions. China has also quickly expanded its TPU capacity in recent years.

There are more than 20 TPU manufacturers in Taiwan, with an annual capacity of more than 100,000 metric tons. Taiwanese TPU producers include Sunko Ink Co. Ltd., Coating Chemical Industry Co. Ltd. and Evermore Chemical Industry Co. Ltd.

China has TPU production facilities in Yantai, Baoding, Jinjiang and Nantong. China consumes nearly 40% of the global TPU output. It also maintains more than 40% of the global TPU capacity.

Major TPU producers and developers include Bayer, Huntsman, Lubrizol, BASF, Wanhua and Sunko.

Important acquisitions in the TPU industry in recent years include:

- Noven was purchased by Lubrizol. Noven has a $1 billion TPU market.
- The Taiwan-based Ure-Tech Co was purchased by Bayer. Ure-Tech holds a large share of the mainland China market.

Thermoplastic Polyurethane Technologies

Modifying TPI or MDI can improve the TPU performance. For example, 1,4-phenylene diisocyanate (PPDI) is a solidification agent for high-performance TPU. Compare to conventional TPU, PPDI-TPU has much higher tensile strength and tearing strength. When the temperature is greater than 120℃, its tensile strength and tearing strength can remain at approximately nine MPa and 10 $kN*m^{-1}$, respectively, which have almost no difference from when it is at 50℃, several times higher than conventional TPUs whose performance drops significantly at high temperature. This means PPDI-TPU has much better thermal resistance than common TPUs.

Other important TPU R&D includes the development of new types of dimethyl-biphenyl diisocyanate (TOPI) TPU and 1,5-naphthalene diisocyanate (NDI) TPU.

European Thermoplastic Polyester Elastomer Market

Thermoplastic polyester elastomer (TPEE) is a blend of polyester and polyether. At low strain condition, TPEE has higher modulus than most other TPEs. TPEE has much higher compression modulus and tensile modulus than its major TPU competitors. In addition, TPEE has excellent low-temperature notched impact strength, abrasion resistance and fatigue resistance.

These advantages allow TPEE to be used in environments that require high performance. Major applications include automotive, industrial products (e.g., hoses, belts) and appliances.

Estimates and forecasts of the TPEE market by application through 2019 are provided in the following table.

TABLE 79

EUROPEAN THERMOPLASTIC POLYESTER ELASTOMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	51.7	54.0	68.0	4.7
Industry (e.g., hoses, belts)	22.6	23.5	28.9	4.1
Appliances	12.2	12.8	15.5	3.9
Others	7.5	7.9	10.0	4.8
Total	94.0	98.2	122.4	4.5

Source: BCC Research

Other Thermoplastic Elastomers

Other TPEs include TPA, TPVC and MPR.

Polyamide Thermoplastic Elastomer

Polyamide thermoplastic elastomer (TPA) is blend of polyamide and polyester or polyether. Like polyamide, TPA has high tensile and toughness, along with good abrasion resistance. It is also resistant to oil and heat, and it has very good processability.

The polyamide segment of TPA could be nylon 6, nylon 66 or nylon 12.

Nylon-12 TPA is regarded as a high-end TPA. It has the potential to be the most common commercialized TPA due to its excellent corrosion resistance and processability. It is usually used to replace fluoroelastomers (FKM and FEPM) and silicone rubber.

The low-end TPAs such as Nylon-6 TPA also have very good market potential. Nylon-6 TPA can be made at a lower cost than TPU while having similar processability as TPEE.

Major TPA applications include wire and cable sheath in automobiles or appliances, footwear, medical tubes and resins modification.

Polyvinyl chloride-Based Thermoplastic Elastomer

Polyvinyl chloride-based thermoplastic elastomer (TPVC) can be designed to have different hardness by adjusting the uses of plasticizers. It has good coloring performance and resistance to weathering, ozone, chemicals, scratching and heat. These advantages make it to good choice for making sealing materials, as well as wire and cable sheath for automobiles, appliance, industrial products, architecture, sports products and medical products, such as blood transfusion bags and tubes.

Melt Processable Rubber

Melt processable rubber (MPR) has excellent elasticity, and it is resistant to heat, oil and many chemicals. Its main performances would not change significantly even after repeated processing. Its resistance to flame, weathering and ozone is better than most other TPEs.

Major MPR applications include sealing strips, sealing pads, wire and cable sheath, footwear and gloves.

Chapter 6

NORTH AMERICAN ELASTOMER MARKET

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 6
NORTH AMERICAN ELASTOMER MARKET

This chapter describes the North American elastomer market. It will break the market down to segments at different levels.

- The North American elastomer market is broken down into two major segments: thermoplastic elastomers (TPEs) and thermoset elastomers (TSEs). Thermoset elastomers are elastomers that irreversibly cure. On the contrary, thermoplastic elastomers are pliable or moldable above specific temperatures and return to solid state upon cooling.

- The TSE segment is further divided to three sub-segments: natural rubber (NR), synthetic rubbers (SRs) and recycled rubbers (RRs). Recycled rubber is also known as reclaimed rubber.

- The Synthetic Rubbers sub-segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, EPR and Others. The EPR section includes EPM and EPDM. The Others section is mostly comprised of saturated rubbers that have relatively small volumes, including ethylene acrylate (AEM), fluoroelastomers (FKM), epichlorohydrin rubber (ECO), silicone rubber (e.g., fluorosilicone [FVMQ]), acrylic elastomer (ACM) and chlorosulfonated polyethylene (CSM).

- The TPE segment is further divided to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs with relatively small volumes of consumption, including TPA, TPVC and MPR.

- A TSE or TPE product may be further broken down into sections by sub-products.

Most segments, sub-segments and sections will be further divided or described by regions and applications. Capacities, technologies, industry trends and leading players will be also discussed.

The following table includes the estimates and forecasts of the two major markets: TSEs and TPEs.

TABLE 80

NORTH AMERICAN ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
Thermoset	3,566.6	3,603.3	3,766.7	0.9
Thermoplastic	967.7	1,001.6	1,178.2	3.3
Total	4,534.3	4,604.9	4,944.9	1.4

Source: BCC Research

North American TSE consumption will have stable growth in the next few years, whereas TPEs will experience stronger growth.

THERMOSET ELASTOMERS

Thermoset elastomers, also known as rubbers, include natural rubber (NR) and synthetic rubbers (SRs). In some countries, the term *synthetic rubber* also includes some types of thermoplastic elastomers, such as thermoplastic styrene elastomers (TPSs), also known as styrenic block copolymers (SBCs). This report excludes all thermoplastic elastomers from the Synthetic Rubber and Rubber categories. As a result, SBCs are put into the Thermoplastic Elastomer category.

Recycled rubbers (RRs), also known as reclaimed rubbers, maintain a significant market share in countries such as China. This report breaks the thermoset elastomer market down into three segments: natural rubbers, synthetic rubbers and recycled rubbers.

Estimates and forecasts of the North American rubber market through 2019 are provided in the following table.

TABLE 81

NORTH AMERICAN THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs	2,446.7	2,483.5	2,677.2	1.5
NR	1,080.0	1,080.0	1050.0	-0.6
RRs	40.0	39.9	39.5	-0.2
Total	3,566.7	3,603.4	3,766.7	0.9

Source: BCC Research

Recycled rubbers include recycled natural rubber (RNR) and recycled synthetic rubber (RSR). Production and consumption of RNR and RSR reached historical heights in the 1990s in the U.S., but the industry has fallen significantly due to stricter environmental constraints.

The estimates and forecasts of North American recycled rubber market by product are shown in the following table.

TABLE 82

NORTH AMERICAN RECYCLED RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
RSRs	32.0	31.9	31.6	-0.2
RNR	8.0	8.0	7.9	-0.3
Total	40.0	39.9	39.5	-0.2

Source: BCC Research

According to experts, 3.0 metric tons of recycled natural rubber can be used to replace 1.0 metric ton of natural rubber, and 1.5 to 2.0 metric tons of recycled synthetic rubber can replace one metric tons of synthetic rubber. Therefore, this report assumes 3.0 metric tons of recycled natural rubber is equal 1.0 metric ton of natural rubber equivalent, and 1.75 metric tons of recycled synthetic rubber equals one metric ton of synthetic rubber equivalent. The numbers of recycled rubber volume in the previous table have been converted into *metric ton natural rubber equivalent* and *metric ton recycled rubber equivalent*.

If RNR is put into the NR segment and RSR is put into the SRs segment, the estimates and forecasts of the North American thermoset elastomer market will resemble those in the following table.

TABLE 83

NORTH AMERICAN THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs*	2,478.7	2,515.4	2,708.8	1.5
NR*	1,088.0	1,088.0	1,057.9	-0.6
Total	3,566.7	3,603.4	3,766.7	0.9

*NR and SRs include recycled rubber volume.

Source: BCC Research

Synthetic rubbers include IR, BR, SBR, NBR, CR, IIR, EPM/EPDM, ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

NATURAL RUBBERS

Natural Rubbers and Compounded Rubbers

In this report, the Natural Rubber segment includes natural rubber and compounded rubbers.

Natural rubber consists of polymers of organic compound isoprene with impurities of other organic compounds plus water. Commercial natural rubbers include standard rubber and ribbed smoked sheet (RSS).

Compounded rubbers usually consist of 95% to 99.5% natural rubbers, which are mostly polyisoprene, with additional chemicals such as stearic acid, styrene butadiene rubber, synthetic polyisoprene (IR), butadiene rubber (BR), carbon black, peptizers and nihil album. In this report, the volume of compounded rubbers does not include additional chemicals.

Nearly 90% of the world’s natural rubber is produced in Southeast Asian countries such as Thailand, Malaysia, Indonesia and Vietnam. In 2013, the global natural rubber acreage was nearly 13.1 million hectares, with a total output of 12.4 million metric tons, up 3.8% from the previous year. Asia produced 11.4 million metric tons, maintaining 92% of the global production.

North American Natural Rubber Consumption by Country

China, Europe, India, the U.S. and Japan are main natural rubber-consuming countries. Major natural rubber producers such as Indonesia, Thailand, Malaysia and Vietnam are also experiencing growing natural rubber consumption, as the global industrial chain has moved some of the capacity of rubber products to these regions.

In North America, the U.S. consumes more than 80% of natural rubber. Estimates of natural rubber consumption and their percentages in major countries in 2013 are provided in the following table.

TABLE 84

NORTH AMERICA NATURAL RUBBER CONSUMPTION BY COUNTRY, 2013 (THOUSAND METRIC TONS/%)

Country	Consumption	Percent
U.S.	890.0	82.4
Canada	110.0	10.2
Mexico	80.0	7.4
Total	1,080.0	100.0

Source: BCC Research

SYNTHETIC RUBBERS

Synthetic rubbers are thermoset elastomers mainly produced from petroleum byproducts. This segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, ERP and Others. The ERP section includes EPM and EPDM. The Others section is comprised mostly of saturated rubbers that have relatively small volumes, including ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

Estimates and forecasts of the North American synthetic rubber market are provided in the following table.

TABLE 85

NORTH AMERICAN SYNTHETIC RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SBR	995.0	1,005.7	1,069.0	1.2
BR	468.0	475.0	511.7	1.5
EPR	320.0	327.0	364.6	2.2
IIR	202.0	203.0	208.1	0.5
NBR	82.0	83.1	88.6	1.3
CR	59.0	59.3	60.8	0.5
IR	58.0	58.2	59.4	0.4
Others	262.7	272.1	314.9	3.0
Total	2,446.7	2,483.4	2,677.1	1.5

Source: BCC Research

SBR will remain the largest segment in the following five years, but its market share will decline.

North American Styrene Butadiene Rubber Market

Styrene butadiene is a copolymer of styrene and butadiene. It comprises the world's largest synthetic rubber family. Major types include emulsion-polymerized styrene butadiene rubber (ESBR) and solution polymerized styrene butadiene rubber (SSBR).

Estimates and forecasts of North American SBR consumption by major types through 2019 are provided in the following table.

TABLE 86

NORTH AMERICAN STYRENE BUTADIENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
ESBR	525.0	519.2	491.3	-1.1
SSBR	470.0	486.5	577.8	3.5
Total	995.0	1,005.7	1,069.0	1.2

Source: BCC Research

ESBR will continue to hold most of the market share, but SSBR will experience a much faster growth.

In North America, oil-extended ESBR accounts for nearly two-thirds of total ESBR consumption. Oil-extended ESBR has lower heat generation, better processability and better flex resistance compared to non-oil extended ESBR. When used for tread, oil-extended ESBR has better traction performance and abrasion resistance. Oil-extended ESBR is mostly used for making tire treads and side walls.

Major SBR applications include tires, automotive components, conveyer belts, hoses, tapes, footwear, medical products and modifiers.

Most SBRs are used for tire manufacturing. Estimates and forecasts of North American SBR consumption by major applications through 2019 are provided in the following table.

TABLE 87

NORTH AMERICAN STYRENE BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	597.0	603.4	641.4	1.2
Automotive	32.9	34.4	39.5	2.8

Others	365.1	367.9	388.1	1.1
Total	995.0	1,005.7	1,069.0	1.2

Source: BCC Research

In tire application, SBR is mostly used for treads, side walls and carcasses. SBR is widely used for tires in passenger cars, tractors and motorcycles. It is rarely used for heavy-duty tires.

In automotive applications, SBR is used for making hoses, V-belts, synchronous belts, O rings, sealing strips and shock-reducing rubbers.

Other applications include footwear, conveyer belts, hoses, tapes, medical products and modifiers.

Styrene Butadiene Rubber Producers

- *Emulsion-Polymerized Styrene Butadiene Rubber Producers*

Leading global ESBR manufacturers include China National Petroleum Corporation (CNPC), Kumho Tires and Sinopec. These three companies produce nearly one-third of the world's capacity.

Capacities of leading ESBR manufacturers and their market shares are provided in the following table.

TABLE 88

LEADING NORTH AMERICAN EMULSION-POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS/%)

Company	Capacity	Percent
Goodyear	360.0	60.0
Ashland	240.0	40.0
Total	600.0	100.0

Source: BCC Research

U.S. ESBR manufacturers reduce their ESBR production or prepare to sell ESBR business due to declined profits.

In early 2014, Lion Copolymer Ltd. decided to temporarily close its Baton Ridge ESBR facility, which had an annual capacity of 135,000 metric tons, due to poor economic conditions in this segment. Lion Copolymer will focus more on its EPDM business after completing a major expansion at the site in 2012.

In July 2013, Ashland Inc. put its styrene-butadiene rubber business, which had a capacity of 240,000 metric tons of ESBR per year and included a 250-employee plant in Port Neches, Texas, up for sale. Ashland acquired the business in August 2011 when it purchased International Specialty Products Inc. (ISP) for approximately $3.2 billion.

- *Solution Polymerized Styrene Butadiene Rubber Producers*

Leading SSBR manufacturers include Styron, Firestone, Michelin, Japan Synthetic Rubber and Goodyear. These four companies produce more than 40% of the world's capacity. Firestone was purchased by Bridgestone and now is part of Bridgestone.

Capacities of leading SSBR manufacturers are provided in the following table.

TABLE 89

LEADING NORTH AMERICAN SOLUTION POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY IN 2013
(THOUSAND METRIC TONS)

Company	Capacity	Products
Firestone, U.S.	180	SSBR/BR
Goodyear, U.S.	80	SSBR/BR
Bayer, U.S.	80	SSBR
Dynasol, Mexico	40	SSBR/BR/SBS
Others	30	SSBR
Total	410	

Source: BCC Research

Styrene Butadiene Rubber Technologies

Leading players in SBR R&D include Goodyear, Bridgestone, Japan Synthetic Rubber Co. Inc., BASF, Dow Chemical and ZEON. They license their manufacturing technologies and patents to manufacturers in Asia, South America and Africa.

Technological trends of emulsion-polymerized styrene butadiene rubber include:

- Higher monomer conversion percentage.
- New functional monomers for improving rubber performance.
- New types of emulsifiers and conditioning agents.
- Environmentally friendly termination agents.
- Powder manufacturing method.

Most manufacturers use technologies based on Phillips' batch polymerization method for SSBR production. Others use continuous polymerization processes based on the Firestone method. Firestone is now part of Bridgestone.

Technological innovations of SSBR mainly focus on microstructure control. An example is developing a functional SSBR with high ethylene content and moderate and controllable styrene content by using new types of multifunctional initiators, couplers and conditioning agents.

North American Butadiene Rubber Market

Butadiene rubber is an elastomer polymerized by 1,3-butadiene monomers, which is a conjugated diene with the formula C_4H_6.

BR is mostly used for making tires. It is also used as an impact-resistance modifier in making high-impact polystyrene (HIPS) and acrylonitrile butadiene styrene (ABS).

Estimates and forecasts of North American BR consumption by major applications through 2019 are provided in the following table.

TABLE 90

NORTH AMERICAN BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	290.2	294.5	314.7	1.3
HIPS	80.0	81.2	87.3	1.5
ABS	13.6	13.8	14.8	1.4
Others	84.2	85.5	95.0	2.1
Total	468.0	475.0	511.7	1.5

Source: BCC Research

In tire applications, BR is mostly used for making treads and side walls. Nd-BR is a promising type due to its advantages such as high tensile strength, low heat generation, low hysteresis loss, excellent flex resistance and wet traction, and low rolling resistance.

As an impact-resistance modifier for HIPS, the additive BR equals to roughly 5% to 8% of HIPS in terms of volume.

As a modifier for making ABS, one kilogram ABS is added with 0.1 kilograms to 0.2 kilograms BR.

BR is also used for making hoses, belts, sports products, automotive parts and other products.

Butadiene Rubber Producers

Major BR producers include Sinopec, Lanxess, Kumho, Michelin, Goodyear, UBE, Eni, CNPC and Sibur.

Butadiene Rubber Technologies

The world's leading players in BR R&D include UBE, Goodyear, Bridgestone, Japan Synthetic Rubber and Lanxess.

- *Ti-BR:* The only large Ti-BR producer is the Russia-based Sibur. This technology could be phased out in the future.
- *Co-BR:* Technological innovations focus on making syndiotactic 1,2 polybutadiene with different crystallinity and melting temperatures.
- *Ni-BR:* The focus is on high cis-hyperbranched BR.
- *Li-BR:* The focus is on the development of low cis BR (LCBR) with different ethylene content.
- *Nd-BR:* The focuses include advanced initiating systems and related polymerization processes, as well as chain-end modification technologies.
- *Others:* Other important trends include making high ethylene content BR by using Mo or Fe initiating systems.

North American Nitrile Rubber Market

Nitrile rubber, also known as acrylonitrile butadiene rubber, Buna-N and Perbunan, is a copolymer of acrylonitrile (ACN) and butadiene. Major types include hydrogenated nitrile rubbers (HNBR), powder nitrile rubbers (PNBR) and carboxylated nitrile rubbers (XNBR).

Estimates and forecasts of North American NBR consumption by major types through 2019 are provided in the following table.

TABLE 91

NORTH AMERICAN NITRILE RUBBER MARKET BY TYPE, THROUGH 2019
(THOUSAND METRIC TONS)

Type	2013	2014	2019	CAGR% 2014–2019
PNBR	82.3	84.4	96.9	2.8
HNBR	58.4	60.4	77.2	5.0
Others	421.3	435.9	514.1	3.4
Total	562.0	580.7	688.2	3.5

Source: BCC Research

Major NBR products include hoses, belts, wire and cable, O rings, adhesives, sealants, footwear and molded products. Many of these products are used in automobiles.

More than 60% of the world's HNBR is used for automotive purposes. Estimates and forecasts of North American HNBR consumption and automotive applications through 2019 are provided in the following table.

TABLE 92

NORTH AMERICAN HYDROGENATED NITRILE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	37.8	39.1	49.9	5.0
Others	20.6	21.3	27.3	5.1
Total	58.4	60.4	77.2	5.0

Source: BCC Research

In North America, an automobile usually consumes 0.4 kilograms to 0.6 kilograms of HNBR.

Nitrile Rubber Producers

The leading global players in NBR production and R&D include Lanxess, ZEON, Bayer, Sinopec, Sibur, JSR and Polimeri. ZEON NBR's trade name is Nipol and Lanxess' NBR is marketed under the trade name Krynac.

Leading North American NBR producers and their capacities are shown in the following table.

TABLE 93

LEADING NORTH AMERICAN NITRILE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013
(THOUSAND METRIC TONS)

Company	Capacity
Lanxess, Canada	40.0
ZEON, U.S.	40.0
East West Copolymer	15.0
Total	95.0

Source: BCC Research

Lanxess and ZEON dominate North American production. East West Copolymer's SBR/NBR plant was purchased from Lion Copolymer.

Nitrile Rubber Technologies

The leading global players of NBR R&D include Lanxess, Bayer, ZEON and Eni.

Major advances in NBR R&D include polymerization formulas, polymerization methods, automatic control technologies and new grades of products.

Focus has been placed on high-efficiency and environmentally friendly polymerization formulas.

New products include specialized and differentiated NBR for different applications, including chain-end NBR, carboxylated nitrile rubber (XNBR), fast-vulcanized NBR, hydrogenate NBR (HNBR), third monomer-copolymerized NBR and powder NBR.

North American Isobutylene Isoprene Rubber Market

Isobutylene isoprene rubber (IIR), also known as butyl rubber, is a copolymer of isobutylene and isoprene. IIR has excellent impermeability and good flex properties. Its air permeability is only one-seventh of natural rubber and one-fifth of styrene butadiene rubber. Its steam permeability is only 1/200 of natural rubber and 1/140 of styrene butadiene rubber.

Most IIRs are halogenated. These halogenated IIRs (HIIRs) include chloro isobutylene isoprene rubber (CIIR) and bromo isobutylene isoprene rubber (BIIR).

Estimates and forecasts of North American IIR and HIIR consumption through 2019 are provided in the following table.

TABLE 94

NORTH AMERICAN ISOBUTYLENE ISOPRENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Products	2013	2014	2019	CAGR% 2014–2019
HIIR	149.5	150.2	154.4	0.6
Others	52.5	52.8	53.7	0.3
Total	202.0	203.0	208.1	0.5

Source: BCC Research

Major IIR products include tires, electric insulation materials, medical bottle plugs, gas masks and sealing materials.

Nearly 50% of North American HIIR is used for tire purposes. Estimates and forecasts of North American HIIR consumption and automotive applications through 2019 are provided in the following table.

TABLE 95

NORTH AMERICAN HALOGENATED ISOBUTYLENE ISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	77.6	77.6	77.0	-0.2
Others	71.9	72.6	77.5	1.3
Total	149.5	150.2	154.4	0.6

Source: BCC Research

In tire applications, IIR is mostly used for making inner liners and inner tubes.

Isobutylene Isoprene Rubber Producers

Exxon Mobil and Lanxess are the world’s two largest IIR producers. Exxon Mobil produces nearly half of the world’s capacity with its subsidiaries and joint ventures.

Leading North American IIR manufacturers and their capacities are shown in the following table.

TABLE 96

LEADING NORTH AMERICAN ISOBUTYLENE ISOPRENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity
Exxon Mobil, U.S.	290.0
Lanxess, Canada	150.0
Total	440.0

Source: BCC Research

ExxonMobil and Lanxess control IIR production in North America.

ExxonMobil has two plants in the U.S.: one in Baton Rouge, Louisiana and another at Baytown. These two plants have a total capacity of nearly 290,000 metric tons of IIR per year. In addition, ExxonMobil has a capacity of nearly 110,000 metric tons of IIR at Fawley, U.K.

Lanxess is the world's second-largest IIR producer. It has three plants. The North American plant is located in Sarnia, Canada, with a capacity of 150,000 metric tons per year. The company also has two plants in Asia and Europe. In 2012, it expanded the production capacity of its plant in Zwijndrecht, Belgium by 10% to 150,000 metric tons per year. In 2013, it launched a new IIR plant in Jurong Island, Singapore, with a total capacity of 100,000 metric tons per year.

Isobutylene Isoprene Rubber Technologies

The leading global players for IIR R&D include Exxon Mobil, Lanxess and Bayer.

R&D of IIR mainly focuses on advanced initiating systems, high polymerization temperature, improved reactors and new products development.

North American Ethylene Propylene Rubber Market

Ethylene propylene rubber (EPR) includes ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM). EPR is resistant to heat, oxidation, ozone, steam, water, chemicals and weathering. It can be used at temperatures from -55°C to 150°C. At 120°C EPR can be used for long periods. Above 120°C, the aging of EPR could be accelerated, and the service life will be shortened. It can also be used under even worse conditions by oxide crosslinking.

EPR has excellent electrical insulation properties. It has low density (0.87), and it can be filled with oil and other materials to lower costs. For high-Mooney viscosity EPR, filling with other materials does not reduce EPR's mechanical properties to a significant degree.

The disadvantages of EPR include poor oil resistance and long cure time, which is three- to four-times longer than most of other synthetic rubbers. In addition, EPR has low adhesiveness to itself and other materials, which makes it difficult to be processed.

Estimates and forecasts of North American EPR consumption by type through 2019 are provided in the following table.

TABLE 97

NORTH AMERICAN ETHYLENE PROPYLENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
EPDM	281.6	287.8	321.2	2.2
EPM	38.4	39.2	43.4	2.1
Total	320.0	327.0	364.6	2.2

Source: BCC Research

EPR is used for automotive components, blend modifications, architecture, wire and cable and tires.

Estimates and forecasts of North American EPR consumption by application through 2019 are provided in the following table.

TABLE 98

NORTH AMERICAN ETHYLENE PROPYLENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	106.4	111.1	129.3	3.1
Blend modifications	64.0	65.4	71.5	1.8
Architecture	54.4	55.6	61.6	2.1
Wire and cable	28.8	29.4	31.4	1.3
Tires	7.4	7.5	8.0	1.3
Others	59.0	58.0	62.9	1.6
Total	320.0	327.0	364.6	2.2

Source: BCC Research

EPR is the most widely-used automotive rubber (except for tire applications). It is used for making sealing strips for automotive doors and windows, ventilation pipes for air conditioners, seal components and hoses.

In the blend-modification application, EPR elastomers are used to improve other rubbers or polymers' resistance to heat, oxidation, ozone, steam and low temperature.

In architectural applications, EPR is used for waterproof rolls, sealing strips and sports tracks.

Ethylene Propylene Rubber Producers

Major EPR producers include Exxon Mobil, Mistsui Chemicals, Lanxess, Dow Chemical, Crompton, DuPont, Herdillia, Kumho, Mitsui Chemicals, Versalis (former Polimeri Europa) and Sumitomo Chemical.

Capacities and shares of major North American manufacturers are shown in the following table.

TABLE 99

LEADING NORTH AMERICAN ETHYLENE PROPYLENE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013
(MILLION METRIC TONS)

Company	Location	Capacity	Trade Name	Method
Exxon Mobil U.S.	Baton Rouge, U.S.	180.0	Vistalon	Solution
Dow Chemical	Plaquemine, U.S.	140.0	Nordel IP	Solution
Lion Copolymer	Geismar, U.S.	134.0	Royalene	Solution
Lanxess U.S.	Ornage, U.S.	70.0	Buna EP	Suspension
Total		524.0		

Source: BCC Research

After selling its SBR facility to East West Copolymer, Lion Copolymer plans to increase its capacity by 66,000 to 88,000 metric tons per year. With this additional capacity, the company's total capacity will exceed 200,000 metric tons per year.

Ethylene Propylene Rubber Technology Research and Development

The leading global players for EPR R&D include Exxon Mobil, Lanxess, Mistsui Chemicals and Bayer. The solution polymerization method dominates the global EPR production.

EPR R&D mainly focuses on advanced initiating systems and polarization modification.

- The initiating systems have moved from V and Ti systems of Ziegler-Natta series to metallocene and low-valence homogeneous systems.

- Polarization modification is usually used for improving EPR's compatibility to other rubbers and materials. Examples include chloration, sulfonation and blending modifications with organic silicon and nylon.

North American Polyisoprene Rubber Markets

Polyisoprene rubber (IR) is a synthetic rubber with similar properties to natural rubber. In some countries, it is called *synthetic natural rubber*. It has better water resistance and electrical insulation than natural rubber, but the strength, adhesiveness and processability of raw rubber and the tearing strength and fatigue resistance of cured rubber are usually slightly lower than natural rubber.

Estimates and forecasts of North American IR consumption by application through 2019 are provided in the following table.

TABLE 100

NORTH AMERICAN POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	34.2	34.4	34.9	0.3
Machinery	12.6	12.6	13.0	0.6
Footwear	1.5	1.5	1.5	0.0
Adhesives and sealants	1.2	1.2	1.2	0.0
Others	8.6	8.6	8.9	0.7
Total	58.1	58.3	59.5	0.4

Source: BCC Research

For tire applications, IR is used in treads, side walls, carcasses, inner liners, belt plies and tire shoulders.

Synthetic Polyisoprene Producers

Major global IR producers include NKNH, Sibur (Togliattikauchuk), Goodyear and Sinopec.

Goodyear is the only IR producer in North America, with an annual capacity of 90,000 metric tons.

Synthetic Polyisoprene Technologies

The leading global players for IR R&D include Goodyear, Bayer, Japan Synthetic Rubber and Kuraray.

Technological trends of IR include:

- *Li-IR:* Cis contents could be increased by introducing active components into lithium initiator. For example, cis content is increased to more than 98% by using n-BuLi with 1, 3-dibromobenzene and triphenylamine

- *Ti-IR:* The most popular initiator could be Ti-based initiators. An example is $TiCl_4$-AIR_3 initiator, which could be added with synergistic-effect third component to improve system activity. Chinese companies use Ti-based initiators to produce Trans-1, 4 polyisoprene (TPI), which has been successfully used for replacing natural rubbers in heavy-duty tires.

- *Nd-IR:* Many companies engage in the innovation and optimization of Nd-based initiating system and polymerization process.

North American Chloroprene Rubber Markets

Chloroprene rubber, also known as polychloroprene or Neoprene, the trade name given by DuPont, is a synthetic rubber produced by polymerization of chloroprene. It has good chemical stability and maintains flexibility over a wide temperature range. CR has good mechanical properties, and it is resistant to oil, heat, flame, sunlight, ozone, acid, alkali and chemicals.

The disadvantages of CR include its relatively bad low-temperature resistance and poor electrical insulation. In addition, CR has low storage stability. The so-called *bin cure* happens during storage of raw CR rubber, which increases Mooney viscosity and makes the rubber harder.

Main applications of CR rubber include adhesives for footwear and architecture, industrial products (e.g., hoses and belts, sealing strips and pads, white-wall tires, cycle tires), and wire and cable.

Estimates and forecasts of the North American CR market by application are provided in the following table.

TABLE 101

NORTH AMERICAN CHLOROPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Industrial products	40.7	40.9	42.0	0.5
Wire and cable	10.6	10.7	11.1	0.7
Adhesives	7.7	7.7	7.7	0.0
Total	59.0	59.3	60.8	0.5

Source: BCC Research

Chloroprene Rubber Producers

Major global CR producers include Denka, DuPont and Lanxess. Global CR capacity reached its historical height of 800,000 metric tons in the 1980s. From the early 1990s and mid-2000s, however, CR was gradually replaced by EPR and other rubbers, especially in automotive applications, and capacity dropped significantly. After 2005, CR demands from Asia, especially China, re-grew due to the booming automobile and real estate markets there. It is estimated that global CR capacity will continue slow growth in the following five years.

DuPont is the only CR supplier in North America. DuPont's capacity fell to 100,000 metric tons per year after it closed its Louisville-based CR facility.

Chloroprene Rubber Technologies

The leading global players for CR R&D include Denka, DuPont, Bayer and Lanxess.

The raw materials of CR are toxic and cause significant damage to the environment, so CR has higher environmental costs than most of other synthetic rubbers. In addition, the manufacturing process is relatively long and costly, so CR has been gradually replaced by other rubbers.

CR is still widely used in adhesives. Current CR R&D mainly focuses on graft modification of solvent-type CR. Graft modification improves the bonding ability between CR and some types of advanced materials. Powder technology is another direction for CR innovations.

North American Markets for Other Synthetic Rubbers

Other important synthetic rubbers include ECO, AEM, FKM, silicone rubber (SIR) and ACM. In this report, silicone rubber includes fluorosilicone rubber (FVMQ).

Globally, nearly one-third of these rubbers are used for automotive purposes (except for tire applications). Estimates and forecasts of some of these rubbers used for automotive purposes are provided in the following table.

TABLE 102

NORTH AMERICAN OTHER SYNTHETIC RUBBER AUTOMOTIVE APPLICATIONS BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
FKM	19.7	20.6	25.0	3.9
SIR	13.1	13.7	17.3	4.8
ECO	11.5	12.0	15.4	5.1

ACM	6.5	6.8	9.6	7.1
AEM	4.9	5.1	7.7	8.6
Total	55.7	58.2	75.0	5.2

Source: BCC Research

Fluorocarbon Rubber

Fluorocarbon (FKM) is resistance to high temperatures, ozone, oxygen, oil and many other chemicals. Under dynamic conditions, the lowest service temperature is approximately 15°C (5°F). Gas permeability is very low and similar to that of butyl rubber. Special FKM compounds exhibit an improved resistance to acids and fuels.

Globally, nearly 60% of FKM is used for the automotive industry. Major applications include fuel hoses, gas pipes, fuel pump and jet device seals, valve stem seals, dynamic seals, piston seals, crankshaft oil seals, universal joint gaskets, O rings and air conditioning compressor seals. An automobile can use 0.2 kilograms to 1.6 kilograms of FKM.

Epichlorohydrin Rubber

Epichlorohydrin (ECO) is a copolymer or homopolymer with similar properties to nitrile rubber, but with better oil and heat resistance. It has low gas permeability and better low temperature flexibility than NBR. It is resistant to acids, alkalis and ozone. Disadvantages of ECO include poor compression set and corrosive effect on metals.

ECO was first developed by two U.S. companies—Goodrich and Hercules—in 1960s. Goodrich produced ECO under the trade name Hydrin, and Hercules produced it under the trade name Herclor. ZEON entered the ECO industry in the 1970s under an agreement with Hercules and another Japanese company. Hydrin currently belongs to ZEON.

ZEON’s Hydrin polymers are used for fuel oil-resistant applications for automobile gaskets, hoses and diaphragms, as well as printer rolls and anti-static applications.

Fluorosilicone Rubber

Fluorosilicone rubber (FVMQ) contains trifluoropropyl groups next to the methyl groups. The mechanical and physical properties are very similar to VMQ. FVMQ offers improved fuel and mineral oil resistance, but poor hot air resistance when compared with silicone rubber (VMQ).

THERMOPLASTIC ELASTOMERS

TPEs include SBC (also known as TPS), TPO, TPV, TPEE, TPU, TPA, TPVC and MPR.

ADVANTAGES AND MARKET DRIVERS

In many applications, TPEs are advanced and better for replacement than TSEs.

- TPEs have simpler manufacturing methods for making end products. For example, making automobile rubber seal strips from ethylene propylene diene monomer (EPDM) requires three steps: mixed compounding, molding and high-temperature vulcanization. Making the same product from TPE only requires a direct molding step. Simpler manufacturing methods largely increase production efficiency.

- TPEs save energy. The processing of $1,000 synthetic rubbers usually consumes more than 1.0 metric tons of standard coal equivalent. According to an automotive manufacturer, the three steps for making 1one kilogram of automobile rubber seal strips of EPDM could consume 2.2 kilohertz to 2.3 kilohertz. The single molding step for making automobile rubber seal strips with TPE usually consumes no more than 0.6 kilohertz per kilogram. The TPE route reduces nearly energy consumption by nearly 75%. Likewise, when compare to making automobile dustproof covers of chloroprene rubber (CR), the TPE route could reduce energy consumption by 70% to 80%.

- TPE is recyclable. There are more than 20 million metric tons of waste rubber per year globally. TPE is more recyclable than synthetic rubbers. Therefore, replacing synthetic rubber with TPE is environmentally friendly.

THERMOPLASTIC ELASTOMER PROUCTS

This report divides the TPE market to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Other sub-segment is comprised of TPEs with relatively small volumes of consumption, including TPA, TPVC and MPR.

North American Styrenic Block Copolymers Market

Styrenic block copolymers (SBC) is the most widely-used thermoplastic elastomer. Major SBC types include SBS, SEBS, SIS and SEPS.

Hydrogenated SBCs, including styrene ethylene butylene styrene (SEBS) and styrene ethylene propylene styrene (SEPS), are relatively new SBC types. They have advantages such as better aging resistance and tensile properties than un-hydrogenated SBCs.

Major applications include adhesives and sealants, asphalt modifiers, polymer modifiers, viscosity index (VI) improvers and footwear.

Estimates and forecasts of the North American SBC market by application can be found in the following table.

TABLE 103

NORTH AMERICAN STYRENIC BLOCK COPOLYMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Asphalt modifiers	168.0	171.9	196.4	2.7
Adhesives and sealants	134.4	137.5	155.0	2.4
Polymer modifiers	50.4	51.6	57.3	2.1
Viscosity index improvers	8.4	8.6	9.6	2.2
Footwear	4.2	4.3	4.6	1.4
Others	54.6	55.9	58.4	0.9
Total	420.0	429.8	481.3	2.3

Source: BCC Research

Styrenic Block Copolymer Producers

Major global SBC producers include Sinopec, Kraton and the LCY Group.

Important North American facilities and their capacities are provided in the following table.

TABLE 104

LEADING NORTH AMERICAN STYRENIC BLOCK COPOLYMER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity	Products
Kraton, U.S.	200.0	SBS/SEBS/SIS/SEPS
Chevron Phillips Chemical, U.S.	100.0	
Dexco, U.S.	60.0	SBS/SIS/SIBS
LCY, U.S.	60.0	SBS/SIS
Dynasol, Mexico	40.0	SBS
Kuraray, U.S.	20.0	SEBS/SEPS
Other U.S. producers	30.0	
Total	510.0	

Source: BCC Research

Styrenic Block Copolymer Technologies

The leading global players for SBC R&D include Kraton, BASF and Japan Synthetic Rubbers.

SBC R&D currently focuses on:

- New initiating system for lowing costs.
- Diversification and functional SBC performances.
- Low-pressure hydrogenation technologies.
- Radiation curing SBC technologies.
- Energy-saving technologies.
- Reversible addition-fragmentation chain transfer (RAFT) polymerization technology for making SBC with excellent heat resistance and solvent resistance.

North American Thermoplastic Polyolefin Market

Thermoplastic polyolefin (TPO), also known as polyolefin elastomer (POE), is a blend of polyolefins and rubbers. The rubber contents are usually EPDM, NBR, IIR or natural rubber. Polyolefins are usually PP or PE. The most widely used TPO is blended by EPDM and PP.

Through a manufacturing method, TPO can be divided by reactor-made thermoplastic polyolefin (RTPO) and blended thermoplastic polyolefin (BTPO).

Most of the world's TPO elastomers are used for automotive purposes, including panels, buffer capsules, tubes, gear covers, sealing materials and interior materials. Other important applications include appliances, machinery, medical, architecture and sports products.

Important TPO brands include Exact by ExxonMobil Chemical and Engage by Dow Chemical.

Estimates and forecasts of the North American TPO market and automotive applications through 2019 are provided in the following table.

TABLE 105

NORTH AMERICAN THERMOPLASTIC POLYOLEFIN MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	106.7	111.4	130.3	3.2
Others	50.2	52.4	62.8	3.7
Total	156.9	163.8	193.1	3.3

Source: BCC Research

North American Thermoplastic Vulcanizate Market

Thermoplastic vulcanizate (TPV) can be perceived as a vulcanized and upgraded version of TPO. TPV has excellent elasticity and compression deformation resistance. It has environmental and aging resistance similar to EPDM. In addition, it has oil and solvent resistance similar to chloroprene rubber. Therefore, TPV is regarded as the more recyclable and environmentally friendly replacement for rubbers, especially to EPDM.

Most of the world's TPV elastomers are used for automotive purposes. For automotive applications, TPV is perfect for sealing strips, tubes and interiors. In developed countries, an automobile could use four kilograms to five kilograms of TPV. In developing countries such as China and India, TPV consumption is usually less than two kilograms per vehicle.

Other important applications include appliances, medical, architecture and sports products.

Estimates and forecasts of the North American TPV market and automotive applications through 2019 are provided in the following table.

TABLE 106

NORTH AMERICAN THERMOPLASTIC VULCANIZATE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	54.3	56.7	69.3	-14.2
Others	21.1	22.1	26.3	34.0
Total	75.4	78.8	95.6	3.9

Source: BCC Research

Thermoplastic Vulcanizate Producers

Major TPV producers and developers include Teknor Apex (Sarlink), Advanced Elastomer Systems Limited (Santoprene, Vyram, Geolast), Dawn (Dawnprene), SK (Plastomer), ZEON (Zeotherm), DuPont (ETPV) and Down Corning (TPSiV).

AES's TPVs products include EPDM, NBR and NR types. Teknor Apex, Dawn and SK's TPVs are mainly EPDM types. ZEON and DuPont products are mainly ACM types. Down Corning's TPSiV is silicon rubber-based.

North American Thermoplastic Polyurethane Market

Thermoplastic polyurethane (TPU) is the first commercialized TPE. It usually consists of rigid blocks formed by diphenyl-methane-diisocyanate (MDI) or toluene diisocyanate (TDI)

reacting with chain extenders and soft blocks formed by MDI or TDI reacting with high molecular polyols.

TPU has the advantages of high tensile strength, good toughness, abrasion resistance and oil resistance. Major applications include shoe materials, automobiles, tires, oil resistant hoses, medical products and waterproof membranes.

TPU can be processed by injection molding, extrusion and coating. Estimates and forecasts of the TPU market by processing method through 2019 are provided in the following table.

TABLE 107

NORTH AMERICAN THERMOPLASTIC POLYURETHANE MARKET BY PROCESSING METHOD, THROUGH 2019
(THOUSAND METRIC TONS)

Processing Method	2013	2014	2019	CAGR% 2014–2019
Extrusion	47.1	48.7	57.6	3.4
Injection molding	40.5	41.8	51.3	4.2
Adhesive	8.5	8.7	10.1	3.0
Coating	7.1	7.4	9.3	4.7
Total	103.2	106.6	128.3	3.8

Source: BCC Research

Major TPU applications include shoe materials, automobiles, engineering, tires, oil resistant hoses, medical products and waterproof membranes.

Estimates and forecasts of the TPU market by application through 2019 are provided in the following table.

TABLE 108

NORTH AMERICAN THERMOPLASTIC POLYURETHANE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Engineering	23.8	24.6	29.5	3.7
Automotive	23.5	24.3	28.7	3.4
Footwear	9.8	9.8	9.9	0.2
Adhesives	8.5	8.7	10.1	3.0
Others	37.6	39.3	50.1	5.0
Total	103.2	106.7	128.3	3.8

Source: BCC Research

Thermoplastic Polyurethane Producers

Taiwan, Europe and the U.S. are major TPU manufacturing regions. China's TPU capacity has quickly expanded in recent years.

There are more than 20 TPU manufacturers in Taiwan, with an annual capacity of more than 100,000 metric tons. Taiwanese TPU producers include Sunko Ink Co. Ltd., Coating Chemical Industry Co. Ltd. and Evermore Chemical Industry Co. Ltd.

China has TPU production facilities in Yantai, Baoding, Jinjiang and Nantong. The country consumes nearly 40% of the global TPU output and holds more than 40% of global TPU capacity.

Major TPU producers and developers include Bayer, Huntsman, Lubrizol, BASF, Wanhua and Sunko.

Important acquisitions in the TPU industry in recent years include:

- Noven was purchased by Lubrizol. Noven has a $1 billion TPU market.
- The Taiwan-based Ure-Tech Co was purchased by Bayer. Ure-Tech holds a large share of the mainland China market.

Thermoplastic Polyurethane Technologies

Modifying TPI or MDI can improve TPU performance. For example, 1,4-phenylene diisocyanate (PPDI) is a solidification agent for high-performance TPU. Compare to conventional TPU, PPDI-TPU has much higher tensile and tearing strengths. When the temperature is greater than 120°C, PPDI-TPU's tensile and tearing strengths can remain at approximately nine MPa and 10 $kN*m^{-1}$, respectively, which have almost no difference from when it is at 50°C, several times higher than conventional TPUs whose performance drops significantly at high temperature. This means PPDI-TPU has much better thermal resistance than common TPUs.

Other important TPU R&D includes the development of new types of dimethyl-biphenyl diisocyanate (TOPI) TPU and 1,5-naphthalene diisocyanate (NDI) TPU.

North American Thermoplastic Polyester Elastomer Market

Thermoplastic polyester elastomer (TPEE) is a blend of polyester and polyether. At low strain condition, TPEE has higher modulus than most of other TPEs. TPEE has much higher compression modulus and tensile modulus than TPU. In addition, TPEE has excellent low-temperature notched impact strength, abrasion resistance and fatigue resistance.

These advantages allow TPEE to be used in environments that require high performance. Major applications include automotive, industrial products (e.g., hoses, belts) and appliances.

Estimates and forecasts of the TPEE market by application through 2019 are provided in the following table.

TABLE 109

NORTH AMERICAN THERMOPLASTIC POLYESTER ELASTOMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	73.0	76.3	97.0	4.9
Industry (e.g., hoses, belts)	30.6	32.2	39.6	4.2
Appliances	15.4	16.1	20.2	4.6
Others	9.0	9.4	11.8	4.7
Total	128.0	134.0	168.6	4.7

Source: BCC Research

Thermoplastic Polyester Elastomer Suppliers

Major global TPEE producers and developers include DuPont, Lanxess (formerly DSM Elastomers) and LG. DuPont’s product is marketed under the brand name Hytrel. LG’s TPEE brand is Keyflex.

Other Thermoplastic Elastomers

Other TPEs include TPA, TPVC and MPR.

Polyamide Thermoplastic Elastomer

Polyamide thermoplastic elastomer (TPA) is blend of polyamide and polyester or polyether. Like polyamide, TPA has high tensile and toughness, as well as good abrasion resistance. It is also resistant to oil and heat, and it has very good processability.

The polyamide segment of TPA could be nylon 6, nylon 66 or nylon 12.

Nylon-12 TPA is regarded as a high-end TPA. It could be the most common commercialized TPA due to its excellent corrosion resistance and processability, and it is usually used to replace fluoroelastomers (FKM and FEPM) and silicone rubber.

The low-end TPAs such as Nylon-6 TPA also have very good market potential. Nylon-6 TPA can be made at a lower cost than TPU while having similar processability as TPEE.

Major TPA applications include wire and cable sheath in automobiles or appliances, footwear, medical tubes, and resins modification.

Polyvinyl Chloride-Based Thermoplastic Elastomer

Polyvinyl chloride-based thermoplastic elastomer (TPVC) can be designed to have different hardness by adjusting the uses of plasticizers. It has good coloring performance, and it is resistant to weathering, ozone, chemicals, scratching and heat. These advantages make it a good choice for sealing materials, as well as for wire and cable sheath for automobiles, appliances, industrial products, architecture, sports products, and medical products such as blood transfusion bags and tubes.

Melt Processable Rubber

Melt processable rubber (MPR) has excellent elasticity and is resistant to heat, oil and many chemicals. Its main performance does not change significantly even after repeated processing. Its resistance to flame, weathering and ozone is better than most other TPEs.

Major MPR applications include sealing strips, sealing pads, wire and cable sheaths, footwear and gloves.

Chapter 7

ASIAN ELASTOMER MARKET

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 7
ASIAN ELASTOMER MARKET

The chapter describes the Asian elastomer market. It breaks the market down into segments at different levels:

- The Asian elastomer market is broken down into two major segment: thermoplastic elastomers (TPEs) and thermoset elastomers (TSEs). Thermoset elastomers are those that irreversibly cure. Thermoplastic elastomers are pliable or moldable above specific temperatures and return to solid state upon cooling.

- The TSE segment is further divided to three sub-segments: natural rubber (NR), synthetic rubbers (SRs) and recycled rubbers (RRs). Recycled rubber is also known as *reclaimed* rubber.

- The Synthetic Rubber sub-segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, EPR and Others. The EPR section includes EPM and EPDM. The Others section is mostly comprised of saturated rubbers that have relatively small volumes, including ethylene acrylate (AEM), fluoroelastomers (FKM), epichlorohydrin rubber (ECO), silicone rubber (e.g. fluorosilicone [FVMQ]), acrylic elastomer (ACM) and chlorosulfonated polyethylene (CSM).

- The TPEs segment is further divided to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs with relatively small volumes of consumption, including TPA, TPVC and MPR.

- A TSE or TPE product may be further broken down into sections by sub-products.

Segments, sub-segments and sections could be further divided or described by countries and applications. Capacities, technologies, industry trends and leading players will be also discussed.

The following table shows the estimates and forecasts of the two major markets: TSEs and TPEs.

TABLE 110

ASIAN ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Products	2013	2014	2019	CAGR% 2014–2019
Thermoset	7,167.5	7,365.7	8,435.5	2.7
Thermoplastic	902.2	922.0	1,104.0	3.7
Total	8,069.7	8,287.7	9,539.5	2.9

Source: BCC Research

TSEs consumption will maintain stable growth in the next few years, whereas TPEs will experience stronger growth.

THERMOSET ELASTOMERS

Thermoset elastomers, also known as rubbers, include natural rubber (NR) and synthetic rubbers (SRs). In some countries, the term *synthetic rubber* also includes some types of thermoplastic elastomers such as thermoplastic styrene elastomers (TPSs), also known as styrenic block copolymers (SBCs). This report excludes all thermoplastic elastomers from the Synthetic Rubber and Rubbercategories. As a result, SBCs are put in the Thermoplastic Elastomer category."

Recycled rubbers (RRs), also known as reclaimed rubbers, hold a significant market share in some countries, such as China. This report breaks the thermoset elastomer market down into three segments:

- Natural rubbers.
- Synthetic rubbers.
- Recycled rubbers.

Estimates and forecasts of the North American rubber market through 2019 are provided in the following table.

TABLE 111

ASIAN THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
NR	4,120.0	4,230.0	4,820.0	2.6
SRs	2,847.0	2,930.7	3,386.5	2.9
RRs	200.5	205.0	228.9	2.2
Total	7,167.5	7,365.7	8,435.5	2.7

Source: BCC Research

Recycled rubbers include recycled natural rubber (RNR) and recycled synthetic rubber (RSR). The estimates and forecasts of the Asian recycled rubber market by product are shown in the following table.

TABLE 112

ASIAN RECYCLED RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs	137.1	140.3	157.2	2.3
NR	63.3	64.7	71.7	2.1
Total	200.4	205.0	228.9	2.2

Source: BCC Research

According to experts, 3.0 metric tons of recycled natural rubber can be used to replace 1.0 metric tons of natural rubber, and 1.5 to 2.0 metric tons of recycled synthetic rubber can replace one metric ton of synthetic rubber. This report therefore assumes that 3.0 metric tons of recycled natural rubber equals one metric ton of natural rubber, and 1.75 metric tons of recycled synthetic rubber equals one metric tons of synthetic rubber. The numbers of recycled rubber volume in the previous table have been converted into *metric ton natural rubber equivalent* and *metric ton recycled rubber equivalent*.

If RNR is put into the NR segment and RSR is put into the SRs segment, the estimates and forecasts of Asian thermoset elastomers market will resemble those in the following table.

TABLE 113

ASIAN THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
NR*	4,183.4	4,294.7	4,891.8	2.6
SRs*	2,984.1	3071.0	3,543.7	2.9
Total	7,167.5	7,365.7	8,435.5	2.7

*NR and SRs here include recycled rubber volume.

Source: BCC Research

Synthetic rubbers include IR, BR, SBR, NBR, CR, IIR, EPM/EPDM, ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

NATURAL RUBBERS

Natural Rubbers and Compounded Rubbers

In this report, the Natural Rubber segment includes natural rubber and compounded rubbers.

Natural rubber consists of polymers of the organic compound isoprene, with impurities of other organic compounds plus water. Commercial natural rubbers include standard rubber and ribbed smoked sheet (RSS).

Compounded rubbers usually consist of 95% to 99.5% natural rubbers, which are mostly polyisoprene, with additional chemicals such as stearic acid, styrene butadiene rubber, synthetic polyisoprene (IR), butadiene rubber (BR), carbon black, peptizers and nihil album. In this report, the volume of compounded rubbers does not include additional chemicals.

Nearly 90% of the world's natural rubbers are produced in Southeast Asian countries such as Thailand, Malaysia, Indonesia and Vietnam. In 2013, the global natural rubber acreage was nearly 13.1 million hectares, with a total output of 12.4 million metric tons, up 3.8% from the previous year. Asia produced 11.4 million metric tons, maintaining 92% of the global production.

Asian Natural Rubber Consumption by Country

China, Europe, India, the U.S. and Japan are major natural rubber-consuming countries. Major natural rubber producers such as Indonesia, Thailand, Malaysia and Vietnam are also experiencing growing natural rubber consumption, as the global industrial chain has moved some of the capacity of rubber products to these regions.

Estimates of natural rubber consumption and their percentages in major countries in 2013 are provided in the following table.

TABLE 114

ASIAN RUBBER CONSUMPTION BY COUNTRY, 2013
(THOUSAND METRIC TONS/%)

Country	Consumption	Percent
India	960	23.3
Japan	700	17.0
Indonesia	600	14.6
Thailand	510	12.4
Malaysia	450	10.9
South Korea	360	8.7
Vietnam	150	3.6
Sri Lanka	120	2.9

Taiwan	110	2.7
Other Asian countries	160	3.9
World total	4,120	100.0

Source: BCC Research

India, Japan and South Korea consumed a large volume of natural rubber due to their big tire industries. In addition, natural rubber-producing countries such as Indonesia, Thailand, Malaysia, Vietnam and Sri Lanka also consumed significant volumes of natural rubber.

Asian Natural Rubber Production by Region

Estimates of Asian natural rubber production by region in 2013 are shown in the following table.

TABLE 115

ASIAN NATURAL RUBBER PRODUCTION BY REGION, 2013
(THOUSAND METRIC TONS/%)

Region	Production	Percent
Thailand	4,010	37.2
Indonesia	3,180	29.5
Vietnam	950	8.8
India	840	7.8
Malaysia	830	7.7
Sri Lanka	130	1.2
Other countries	130	1.2
Total	10,070	93.4

Source: BCC Research

Asia produced approximately 90% of the world’s natural rubber. Thailand alone contributed nearly one-third of the global production.

SYNTHETIC RUBBERS

Synthetic rubbers are thermoset elastomers produced mainly from petroleum byproducts. This segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, ERP and Others.

The ERP section includes EPM and EPDM. The Other section is comprised mostly of saturated rubbers that have relatively small volumes, including ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

SBR and BR are most widely used synthetic rubbers. These two rubbers, together, account for nearly two-thirds of the global synthetic rubber consumption. EPR, IIR and NBR also have big shares in the market.

Estimates and forecasts of the Asian synthetic rubber market through 2019 are provided in the following table.

TABLE 116

ASIAN SYNTHETIC RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SBR	955.0	980.4	1,123.1	2.8
BR	860.0	890.1	1,057.2	3.5
EPR	268.0	272.3	294.8	1.6
IIR	250.0	260.0	316.3	4.0
NBR	142.0	146.4	170.5	3.1
IR	74.0	75.1	81.3	1.6
CR	81.0	81.6	85.0	0.8
Others	217.0	224.8	258.4	2.8
Total	2,847.0	2,930.7	3,386.6	2.9

Source: BCC Research

SBR will remain the largest segment in the following five years, but its market share will decline.

Asian Styrene Butadiene Rubber Market

Styrene butadiene, a copolymer of styrene and butadiene, comprises the world’s largest synthetic rubber family. Major types include emulsion-polymerized styrene butadiene rubber (ESBR) and solution polymerized styrene butadiene rubber (SSBR).

Estimates and forecasts of Asian SBR consumption by product through 2019 are provided in the following table.

TABLE 117

ASIAN STYRENE BUTADIENE RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
ESBR	715.0	726.5	786.5	1.6
SSBR	240.0	253.9	336.6	5.8
Total	955.0	980.4	1,123.1	2.8

Source: BCC Research

ESBR will continue to maintain most of the market share, but SSBR will experience much faster growth.

In Asia, oil-extended ESBR accounts for nearly 50% of total ESBR consumption. Oil-extended ESBR has lower heat generation, better processability and better flex resistance compared to the non-oil extended type. When used for tread, oil-extended ESBR has better traction performance and abrasion resistance. Oil-extended ESBR is mostly used for making tire treads and side walls.

Major SBR applications include tires, automotive components, conveyer belts, hoses, tapes, footwear, medical products and modifiers.

Most SBR are used for tire manufacturing. Estimates and forecasts of Asian SBR consumption by major applications through 2019 are provided in the following table.

TABLE 118

ASIAN STYRENE BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	601.6	617.7	707.6	2.8
Automotive	37.5	37.4	39.6	1.1
Others	315.9	325.3	375.9	2.9
Total	955.0	980.4	1,123.1	2.8

Source: BCC Research

In tire applications, SBR is mostly used for treads, side walls and carcasses. It is widely used for tires in passenger cars, tractors and motorcycles. It is rarely used for heavy-duty tires.

In automotive applications, SBR is used for making hoses, V-belts, synchronous belts, O rings, sealing strips and shock-reducing rubber.

Other applications include footwear, conveyer belts, hoses, tapes, medical products and modifiers.

Styrene Butadiene Rubber Producers

- *Emulsion-Polymerized Styrene Butadiene Rubber Producers*

Leading global ESBR manufacturers include China National Petroleum Corporation (CNPC), Kumho Tires and Sinopec. These three companies produce nearly one-third of the world's capacity.

Capacities of leading ESBR manufacturers and their market shares are provided in the following table.

TABLE 119

LEADING ASIAN EMULSION-POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS/%)

Company	Capacity	Percent
Kumho	480	44.4
ZEON	190	17.6
JSR	130	12.0
TSRC	100	9.3
Others	180	16.7
Total	1,080	100.0

Source: BCC Research

Production of Asian ESBR companies remained in the past few years. Manufacturers in Japan, South Korea and Taiwan export approximately 80,000 metric tons of ESBR, mostly oil-extended ESBR, to China per year.

- *Solution Polymerized Styrene Butadiene Rubber Producers*

Leading SSBR manufacturers include Styron, Firestone, Michelin, Japan Synthetic Rubber and Goodyear. These four companies produce more than 40% of the world's capacity. Firestone now is part of Bridgestone.

In Asia, the Japanese companies JSR, ZEON and Asahi Kasei produce most of the capacity. The South Korean producer Kumho also holds a large share.

TABLE 120

LEADING ASIAN SOLUTION POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013 (THOUSAND METRIC TONS)

Company	Capacity	Products
JSR (Japan, Thailand)	110	SSBR
Asahi Kasei (Japan, Singapore)	110	SSBR
Kumho	80	SSBR/BR/SBS
ZEON	60	SSBR/BR
Others	80	SSBR
World total	440	

Source: BCC Research

Styrene Butadiene Rubber Technologies

Leading players in SBR R&D include Goodyear, Bridgestone, Japan Synthetic Rubber Co. Inc., BASF, Dow Chemical and ZEON. They license their manufacturing technologies and patents to manufacturers in Asia, South America and Africa.

Technological trends of emulsion-polymerized styrene butadiene rubber include:

- Higher monomer conversion percentage.
- New functional monomers for improving rubber performance.
- New types of emulsifiers and conditioning agents.
- Environmentally friendly termination agents.
- Powder manufacturing method.

Most manufacturers use manufacturing technologies based on the Phillips' batch polymerization method for SSBR production. Others use continuous polymerization processes based on the Firestone method. Firestone is now part of Bridgestone.

Technological innovations of SSBR mainly focus on microstructure control. An example is developing a functional SSBR with high ethylene content and moderate and controllable styrene content by using new types of multifunctional initiators, couplers and conditioning agents.

Asian Butadiene Rubber Market

Butadiene rubber is an elastomer polymerized by 1,3-butadiene monomers, which is a conjugated diene with the formula C_4H_6.

BR is mostly used for making tires. It is also used as an impact-resistance modifier for making high-impact polystyrene (HIPS) and acrylonitrile butadiene styrene (ABS).

Estimates and forecasts of Asian BR consumption by major applications through 2019 are provided in the following table.

TABLE 121

ASIAN BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	567.6	587.4	699.9	3.6
HIPS	89.4	92.6	109.9	3.5
ABS	43.0	44.5	52.9	3.5
Others	160.0	165.6	194.5	3.3
Total	860.0	890.1	1,057.2	6.1

Source: BCC Research

In tire applications, BR is mostly used for making treads and side walls. Nd-BR is a promising type due to its advantages such as high tensile strength, low heat generation, low hysteresis loss, excellent flex resistance and wet traction, and low rolling resistance.

As an impact-resistance modifier for HIPS, the additive BR equals 5% to 8% of HIPS in terms of volume.

As a modifier for making ABS, one kilogram ABS is added with 0.1 kilograms to 0.2 kilograms BR.

BR is also used for making hoses, belts, sports products, automotive parts and other products.

Butadiene Rubber Producers

Major BR producers include Sinopec, Lanxess, Kumho, Michelin, Goodyear, UBE, Eni, CNPC and Sibur.

Butadiene Rubber Technologies

The leading global players in BR R&D include UBE, Goodyear, Bridgestone, Japan Synthetic Rubber and Lanxess.

- *Ti-BR:* The only large Ti-BR producer is the Russia-based Sibur. This technology could be phased out in the future.
- *Co-BR:* Technological innovations focus on making syndiotactic 1,2 polybutadiene with different crystallinity and melting temperatures.

- *Ni-BR:* The focus is on high cis-hyperbranched BR.
- *Li-BR:* The focus is developing low-cis BR (LCBR) with different ethylene content.
- *Nd-BR:* The focuses include advanced initiating systems and related polymerization processes, as well as chain-end modification technologies.
- *Others:* Other important trends include making high ethylene content BR by using Mo or Fe initiating systems.

Asian Nitrile Rubber Market

Nitrile rubber, also known as acrylonitrile butadiene rubber, Buna-N and Perbunan, is a copolymer of acrylonitrile (ACN) and butadiene. Major types include hydrogenated nitrile rubbers (HNBR), powder nitrile rubbers (PNBR) and carboxylated nitrile rubbers (XNBR).

Estimates and forecasts of Asian NBR consumption by major products through 2019 are provided in the following table.

TABLE 122

ASIAN NITRILE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
PNBR	17.0	17.6	20.5	3.1
HNBR	14.3	14.3	16.4	2.8
Others	110.7	114.5	133.6	3.1
Total	142.0	146.4	170.5	3.1

Source: BCC Research

Major NBR applications include hoses, belts, wire and cable, O rings, adhesives, sealants, footwear and molded products. Many of these products are used in automobiles.

More than 60% of Asian HNBR is used for automotive purposes. Estimates and forecasts of Asian HNBR consumption and automotive applications through 2019 are provided in the following table.

TABLE 123

ASIAN HYDROGENATED NITRILE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	9.3	9.3	10.6	2.7
Others	5.0	5.0	5.8	3.0
Total	14.3	14.3	16.4	2.8

Source: BCC Research

In Asia, an automobile usually consumes 0.4 kilograms to 0.6 kilograms of HNBR.

Nitrile Rubber Producers

The leading global players of NBR production and R&D include Lanxess, ZEON, Bayer, Sinopec, Sibur, JSR and Polimeri. ZEON and JSR are located in Japan, but they have expanded their production to other countries. ZEON NBR's trade name is Nipol, and Lanxess' NBR is marketed under the trade name Krynac.

Nitrile Rubber Technologies

The leading global players of NBR R&D include Lanxess, Bayer, ZEON and Eni.

Major advances in NBR R&D include polymerization formulas, polymerization methods, automatic control technologies and new grades of products.

The focus is on improved high-efficiency and environmentally friendly polymerization formulas.

New products are specialized and differentiated NBR for different applications. They include chain-end NBR, carboxylated nitrile rubber (XNBR), fast-vulcanized NBR, hydrogenate NBR (HNBR), third monomer-copolymerized NBR and powder NBR.

Asian Isobutylene Isoprene Rubber Market

Isobutylene isoprene rubber, also known as butyl rubber, is a copolymer of isobutylene and isoprene. IIR has excellent impermeability and good flex properties. Its air permeability is only one-seventh of natural rubber and one-fifth of styrene butadiene rubber. Its steam permeability is only 1/200 of natural rubber and 1/140 of styrene butadiene rubber.

Most IIRs are halogenated. The halogenated IIRs (HIIRs) include chloro isobutylene isoprene rubber (CIIR) and bromo isobutylene isoprene rubber (BIIR).

Estimates and forecasts of Asian IIR and HIIR consumption through 2019 are provided in the following table.

TABLE 124

ASIAN ISOBUTYLENE ISOPRENE RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
HIIR	185.0	192.4	234.7	4.1
Others	65.0	67.6	81.6	3.8
Total	250.0	260.0	316.3	4.0

Source: BCC Research

Major IIR applications include tires, electric insulation materials, medical bottle plugs, gas masks and sealing materials.

Approximately 80% of Asian HIIRs are used for tire purposes. Estimates and forecasts of Asian HIIR consumption and automotive applications through 2019 are provided in the following table.

TABLE 125

ASIAN HALOGENATED ISOBUTYLENE ISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	150.4	154.4	186.1	3.8
Others	34.6	38.0	48.7	5.1
Total	185.0	192.4	234.7	4.1

Source: BCC Research

In tire applications, IIR is mostly used for making inner liners and inner tubes.

Isobutylene Isoprene Rubber Producers

Exxon Mobil and Lanxess are the world’s two largest IIR producers. Exxon Mobil produces nearly half of the world’s capacity with its subsidiaries and joint ventures.

Leading Asian IIR manufacturers and their capacities are shown in the following table.

TABLE 126

LEADING ASIAN ISOBUTYLENE ISOPRENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity	Percent
JSC, Japan	178.0	13.2
Lanxess, Singapore	100.0	7.4
World total	1,348.0	100.0

Source: BCC Research

Japan Butyl Co. Ltd. (JBC) and Lanxess control IIR production in Asia. JBC is a joint venture of ExxonMobil Yugen Kaisha (EMYK) and JSR Kabushiki Kaisha. The company serves as a supply base for butyl rubber primarily in Asia, with a capacity of 145,000 metric tons per year. ExxonMobil Yugen Kaisha holds a 50% stake in JBC. EMYK is an affiliate of ExxonMobil Chemical.

In 2010, JBC completed a major expansion to increase butyl rubber production capacity at its plant in Kawasaki, Japan. The expansion added 18,000 tons per year of production capacity bringing the plant's total capacity to 98,000 tons per year.

In 2013, JBC expanded the capacity of its halobutyl rubber manufacturing plant at Kashima, Japan to 80,000 tons per year.

JBC currently has a total annual capacity of 178,000 tons of IIR.

Lanxess is the world's second-largest IIR producer. It has three plants. The Asian plant is located in Jurong Island, Singapore, with a total capacity of 100,000 metric tons per year. Its other two plants are in Europe and North America. In 2012, it expanded the production capacity of its plant in Zwijndrecht, Belgium by 10% to 150,000 metric tons per year. Lanxess has another IIR plant in Sarnia, Canada, with a capacity of 150,000, metric tons per year.

Isobutylene Isoprene Rubber Technologies

The leading global players for IIR R&D include Exxon Mobil, Lanxess and Bayer.

R&D of IIR mainly focuses on advanced initiating systems, high polymerization temperature, improved reactors and new products development.

Asian Ethylene Propylene Rubber Market

Ethylene propylene rubber includes ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM). EPR is resistant to heat, oxidation, ozone, steam, water, chemicals and weathering. It can be used at temperatures from -55°C to 150°C. At 120°C EPR can also be used for long periods. Above 120°C, the aging of EPR could be accelerated,

and the service life will be shortened. By oxide crosslinking, EPR can be used under worse conditions.

EPR has excellent electrical insulation properties. It has low density (0.87) and can be filled with oil and other materials to lower costs. For high-Mooney viscosity EPR, filling with other materials does not reduce EPR's mechanical properties to a significant degree.

The disadvantages of EPR include poor oil resistance and long cure time, which is three- to four-times longer than most of other synthetic rubbers. In addition, EPR has low adhesiveness to itself and other materials, which make it difficult to be processed.

Estimates and forecasts of Asian EPR consumption by product through 2019 are provided in the following table.

TABLE 127

ASIAN ETHYLENE PROPYLENE RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
EPDM	225.1	228.7	248.2	1.6
EPM	42.9	43.6	46.6	1.3
Total	268.0	272.3	294.8	1.6

Source: BCC Research

EPR is used for automotive, blend modification, architecture, wire and cable and tires. Estimates and forecasts of Asian EPR consumption by application through 2019 are provided in the following table.

TABLE 128

ASIAN ETHYLENE PROPYLENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	124.7	124.2	133.5	1.4
Blend modifications	32.2	32.7	35.7	1.8
Architecture	18.8	19.1	20.9	1.8
Wire and cable	10.7	10.9	11.5	1.1
Tires	6.2	6.3	6.8	1.5
Others	75.4	79.1	86.4	1.8
Total	268.0	272.3	294.8	1.6

Source: BCC Research

EPR is the most widely used automotive rubber (except for tire applications). EPR is used for making sealing strips for automotive doors, as well as windows, ventilation pipes of air conditioners, seal components and hoses.

In blend-modification application, EPR is used to improve other rubbers or polymers' resistance to heat, oxidation, ozone, steam and low temperature.

In architectural application, EPR is used for waterproof rolls, sealing strips and sports tracks.

Ethylene Propylene Rubber Producers

Major EPR producers include Exxon Mobil, Mistsui Chemicals, Lanxess, Dow Chemical, Crompton, DuPont, Herdillia, Kumho, Mitsui Chemicals, Versalis (former Polimeri Europa) and Sumitomo Chemical.

Capacities and shares of major Asian EPR manufacturers are shown in the following table.

TABLE 129

LEADING ASIAN (EXCEPT CHINA) ETHYLENE PROPYLENE RUBBER MANUFACTURERS BY CAPACITY, 2012-2013 (MILLION METRIC TONS)

Company	Location	Capacity	Trade Name	Method
Mitsui Chemicals	Japan	120	Mitsui EPT	Solution
Kumho	South Korea	50	Vistalon	Solution
Sumitomo Chemical	Japan	43	Esprene	Solution
SK	South Korea	40	Suprene	Solution
JSR	Japan	36	JSR EP	Solution
Herdilla	India	11	Herlene	Solution
Total		300		

Source: BCC Research

Mitsui Chemicals contributes approximately 40% of Asian EPR production.

Ethylene Propylene Rubber Technology Research and Development

The leading global players for EPR R&D include Exxon Mobil, Lanxess, Mistsui Chemicals and Bayer. The solution polymerization method dominates the global EPR production.

EPR R&D mainly focuses on advanced initiating systems and polarization modification.

- The initiating systems have moved from V and Ti systems of Ziegler-Natta series to metallocene and low-valence homogeneous systems.

- Polarization modification is usually used for improving EPR's compatibility to other rubbers and materials. Examples include chloration, sulfonation, and blending modifications with organic silicon and nylon.

Asian Polyisoprene Rubber Markets

Polyisoprene rubber (IR) is a synthetic rubber with similar properties to natural rubber, so in some countries, it is called *synthetic natural rubber*. It has better water resistance and electrical insulation than natural rubber, but the strength, adhesiveness and processability of raw rubber and tearing strength and fatigue resistance of cured rubber are usually slightly lower than natural rubber.

Estimates and forecasts of Asian IR consumption by application through 2019 are provided in the following table.

TABLE 130

ASIAN POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	61.3	62.3	67.2	1.5
Machinery	4.6	4.6	5.1	2.1
Adhesives and sealants	2.9	2.9	3.2	2.0
Footwear	2.0	2.1	2.3	1.8
Others	3.2	3.2	3.5	1.8
Total	74.0	75.1	81.3	1.6

Source: BCC Research

For tire applications, IR is used in treads, side walls, carcasses, inner liners, belt plies and tire shoulders.

Japan consumes most of the IR in Asia, maintaining nearly two-thirds of Asian consumption, but the share will decline in the next five years.

Estimates and forecasts of Japanese IR consumption by application through 2019 are provided in the following table.

TABLE 131

JAPANESE POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	40.6	40.7	41.5	0.4
Machinery	2.9	2.9	3.0	0.7
Adhesives and sealants	1.8	1.8	1.9	1.1
Footwear	0.7	0.7	0.7	0.0
Others	2.0	2.0	2.1	1.0
Total	48.0	48.1	49.2	0.4

Source: BCC Research

Other Asian consumption occurs mostly from India, South Korea and Taiwan. Their estimates and forecasts by application through 2019 are provided in the following table.

TABLE 132

OTHER ASIAN COUNTRIES POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014-2019
Tires	20.8	21.5	25.7	3.6
Machinery	1.7	1.8	2.1	3.1
Footwear	1.3	1.3	1.6	4.2
Adhesives and sealants	1.0	1.1	1.3	3.4
Others	1.2	1.2	1.5	4.6
Total	26.0	26.9	32.2	3.6

Source: BCC Research

Synthetic Polyisoprene Producers

Major global IR producers include NKNH, Sibur (Togliattikauchuk), Goodyear and Sinopec.

Leading Asian producers and their capacities are provided in the following table.

TABLE 133

LEADING ASIAN SYNTHETIC POLYISOPRENE MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity
ZEON, Japan	40.0
JSR, Japan	36.0
Total	76.0

Source: BCC Research

There are only two IR producers in Asia and they are located in Japan

Synthetic Polyisoprene Technologies

The leading global players for IR R&D include Goodyear, Bayer, Japan Synthetic Rubber and Kuraray.

Technological trends of IR include:

- *Li-IR:* Cis contents could be increased by introducing active components into lithium initiators. For example, cis content is increased to more than 98% by using n-BuLi with 1, 3-dibromobenzene and triphenylamine.

- *Ti-IR:* The most popular initiator could be Ti-based initiators. An example is $TiCl_4$-AIR_3 initiator, which could be added with synergistic-effect third component for improving system activity. Chinese companies use Ti-based initiators to produce Trans-1, 4 polyisoprene (TPI), which has been successfully used for replacing natural rubbers in heavy-duty tires.

- *Nd-IR:* Many companies engage in the innovation and optimization of Nd-based initiating system and polymerization process.

Asian Chloroprene Rubber Markets

Chloroprene rubber, also known as polychloroprene or Neoprene, the trade name given by DuPont, is a synthetic rubber produced by polymerization of chloroprene. It has good chemical stability and maintains flexibility over a wide temperature range. CR has good mechanical properties and is resistant to oil, heat, flame, sunlight, ozone, acid, alkali and chemicals.

The disadvantages of CR include its relatively bad low-temperature resistance and poor electrical insulation. In addition, CR has low storage stability. The so-called *bin cure* occurs in storage of raw CR rubber, which increases Mooney viscosity and makes the rubber harder.

Main applications of CR rubber include adhesives for footwear and architecture, industrial products (e.g., hoses and belts, and sealing strips and pads, white-wall tires, cycle tires), and wire and cable.

Estimates and forecasts of the Asian CR market by application are provided in the following table.

TABLE 134

ASIAN CHLOROPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014-2019
Industrial products	38.9	39.2	41.6	1.1
Adhesives	31.6	31.8	32.3	0.3
Wire and cable	10.5	10.6	11.1	0.9
Total	81.0	81.6	85.0	0.8

Source: BCC Research

Chloroprene Rubber Producers

Major global CR producers include Denka, DuPont and Lanxess. Global CR capacity reached its historical height of 800,000 metric tons in the 1980s. From the early 1990s and mid-2000s, however, CR was gradually replaced by EPR and other rubbers, especially in automotive applications, and capacity dropped significantly. After 2005, CR demands from Asia, especially China, re-grew due to the booming automobile and real estate markets there. It’s estimated that global CR capacity will continue slow growth in the following five years.

Leading Asian CR manufacturers and their capacities are listed in the following table.

TABLE 135

LEADING ASIAN CHLOROPRENE RUBBER MANUFACTURERS BY CAPACITY, 2013 (THOUSAND METRIC TONS)

Company	Capacity
Denka, Japan	70.0
Tosoh, Japan	34.0
Showa Denka	25.0
Total	129.0

Source: BCC Research

Denka and its subsidiary Showa Denka have a total capacity of 95,000 metric tons per year.

Chloroprene Rubber Technologies

The leading global players for CR R&D include Denka, DuPont, Bayer and Lanxess.

The raw materials of CR are toxic and cause great damage to the environment, so CR has higher environmental costs than most other synthetic rubbers. In addition, the manufacturing process is relatively long and costly, so CR has been gradually replaced by other rubbers.

CR is still widely used in adhesives. R&D for CR currently focuses on graft modification of solvent-type CR. Graft modification improves the bonding ability between CR and some types of advanced materials. Powder technology is another direction for CR innovations.

Asian Markets for Other Synthetic Rubbers

Other important synthetic rubbers include ECO, AEM, FKM, silicone rubber (SIR) and ACM. In this report, silicone rubber includes fluorosilicone rubber (FVMQ).

In Asia, nearly one-third of these rubbers are used for automotive purposes (except for tire applications). Estimates and forecasts of some of these rubbers used for automotive purposes are provided in the following table.

TABLE 136

ASIAN OTHER SYNTHETIC RUBBER AUTOMOTIVE APPLICATIONS BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
FKM	22.5	22.4	25.1	2.3
SIR	15.0	14.9	17.3	3.0
ECO	13.1	13.0	15.4	3.4
ACM	7.5	7.4	9.6	5.3
AEM	5.6	5.6	7.7	6.6
Total	63.7	63.3	75.1	3.5

Source: BCC Research

Fluorocarbon Rubber

Fluorocarbon (FKM) is resistant to high temperatures, ozone, oxygen, oil and many other chemicals. Under dynamic conditions, the lowest service temperature is roughly 15°C

(5°F). Gas permeability is very low and similar to that of butyl rubber. Special FKM compounds exhibit an improved resistance to acids and fuels.

Globally, approximately 60% of FKM is used for automotive industry. Major applications include fuel hoses, gas pipes, fuel pumps and jet device seals, valve stem seals, dynamic seals, piston seals, crankshaft oil seals, universal joint gaskets, O rings and air conditioning compressor seals. An automobile could use 0.2 kilograms to 1.6 kilograms of FKM.

Epichlorohydrin Rubber

Epichlorohydrin (ECO) is copolymer or homopolymer having similar properties to nitrile rubber, but with better oil and heat resistance. It has a low gas permeability and better low-temperature flexibility than NBR. It is resistant to acids, alkalis and ozone. Disadvantages of ECO include poor compression set and corrosive effect on metals.

ECO was first developed by two U.S. companies—Goodrich and Hercules—in 1960s. Goodrich produced ECO under the trade name Hydrin, and Hercules produced it under the trade name Herclor. ZEON entered the ECO industry in the 1970s under an agreement with Hercules and another Japanese company. Hydrin currently belongs to ZEON.

ZEON’s Hydrin polymers are used for fuel oil-resistant applications for automobile gaskets, hoses, diaphragms printer rolls and anti-static applications.

Fluorosilicone Rubber

Fluorosilicone rubber (FVMQ) contains trifluoropropyl groups next to the methyl groups. The mechanical and physical properties are similar to VMQ. FVMQ, however, offers improved fuel and mineral oil resistance, but poor hot air resistance when compared with silicone rubber (VMQ).

THERMOPLASTIC ELASTOMERS

TPEs include SBC (also known as TPS), TPO, TPV, TPEE, TPU, TPA, TPVC and MPR.

ADVANTAGES AND MARKET DRIVERS

In many applications, TPEs are advanced and better replacements than TSEs.

- TPEs have simpler manufacturing methods for making end products. For example, making automobile rubber seal strips from ethylene propylene diene monomer (EPDM) requires three steps: mixed compounding, molding and high-temperature vulcanization. Making the product from TPE only requires one direct molding step. Simpler manufacturing methods largely increase production efficiency.

- TPE saves energy. Processing $1,000 worth of synthetic rubber usually consumes more than one metric ton of standard coal equivalent. According to an automotive manufacturer, the three steps for making one kilogram of automobile rubber seal strips of EPDM could consume a total 2.2 kilowatts to 2.3 kilowatts. The single molding step for making automobile rubber seal strips of TPE usually consumes no more than 0.6 kilowatts per kilogram. The TPE route reduces energy consumption by nearly 75%. Likewise, compared to making automobile dustproof cover of chloroprene rubber (CR), the TPE route could reduce energy consumption by 70% to 80%.

- TPE is recyclable. There are more than 20 million metric tons of waste rubbers per year globally. TPE is more recyclable than synthetic rubbers. Therefore, replacing synthetic rubbers with TPE is environmentally friendly.

THERMOPLASTIC ELASTOMERS PROUCTS

This report divides the TPE market to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs with relatively small volumes of consumption, including TPA, TPVC and MPR.

Asian Styrenic Block Copolymers Market

Styrenic block copolymers (SBC) comprise the most widely used thermoplastic elastomer. Major SBC types include SBS, SEBS, SIS and SEPS.

Hydrogenated SBCs, including styrene ethylene butylene styrene (SEBS) and styrene ethylene propylene styrene (SEPS), are relatively new SBC types. They have advantages over un-hydrogenated SBCs such as better aging resistance and tensile properties.

Major applications include adhesives and sealants, asphalt modifiers, polymer modifiers, viscosity index (VI) improvers and footwear.

Estimates and forecasts of the Asian SBC market by application are listed in the following table.

TABLE 137

ASIAN STYRENIC BLOCK COPOLYMER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Asphalt modifiers	86.8	89.8	108.4	3.8
Adhesives and sealants	68.2	70.5	83.7	3.5
Footwear	65.1	67.3	77.7	2.9
Polymer modifiers	49.6	51.3	59.9	3.1
Viscosity index improvers	3.1	3.2	3.7	2.9

Others	37.2	38.5	45.5	3.4
Total	310.0	320.6	378.9	3.4

Source: BCC Research

Styrenic Block Copolymer Producers

Major global SBC producers include Sinopec, Kraton and the LCY Group.

Important facilities and their capacities in Asia in 2013 are provided in the following table.

TABLE 138

LEADING ASIAN STYRENIC BLOCK COPOLYMER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity	Product
LCY, Taiwan	140.0	SBS/SIS/SEBS
Kumho, South Korea	70.0	SBS/SEBS
LG, Korea	70.0	SBS
Asahi Kasei, Japan	60.0	SBS/SEBS
TSRC, Taiwan	60.0	SBS/SIS/SEBS
Kraton-JSR	50.0	SBS/SIS
Kuraray, Japan	20.0	SEBS/SEPS
Other Taiwanese companies	100.0	SBS
Other Japanese companies	70.0	SBS/SIS/SEBS
Total	640.0	

Source: BCC Research

Styrenic Block Copolymer Technologies

The leading global players for SBC R&D include Kraton, BASF and Japan Synthetic Rubbers.

SBC R&D currently focuses on:

- New initiating system for lowing costs.
- Diversification and functional SBC performances.
- Low-pressure hydrogenation technologies.
- Radiation SBC curing technologies.
- Energy-saving technologies.
- Reversible addition-fragmentation chain transfer (RAFT) polymerization technology for making SBC with excellent heat resistance and solvent resistance.

Asian Thermoplastic Polyolefin Market

Thermoplastic polyolefin (TPO), also known as polyolefin elastomer (POE), is a blend of polyolefins and rubbers. The rubber contents are usually EPDM, NBR, IIR or natural rubber. Polyolefins are usually PP or PE. The most widely used TPO is blended by EPDM and PP.

Through a manufacturing method, TPO can be divided by reactor-made thermoplastic polyolefin (RTPO) and blended thermoplastic polyolefin (BTPO).

Most of the world's TPO elastomers are used for automotive purposes, including panels, buffer capsules, tubes, gear covers, sealing materials and interior materials. Other important applications include appliances, machinery, medical, architecture and sports products.

Important TPO brands include Exact by ExxonMobil Chemical and Engage by Dow Chemical.

Estimates and forecasts of the Asian TPO market and automotive applications through 2019 are provided in the following table.

TABLE 139

ASIAN THERMOPLASTIC POLYOLEFIN MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	162.6	161.9	189.4	3.2
Others	83.8	83.4	98.4	3.4
Total	246.4	245.3	287.8	3.2

Source: BCC Research

Asian Thermoplastic Vulcanizate Market

Thermoplastic vulcanizate (TPV) can be perceived as a vulcanized and upgraded version of TPO. TPV has excellent elasticity and compression deformation resistance. It has environment resistance and aging resistance similar to EPDM. In addition, it has oil and solvent resistance similar to chloroprene rubber. Therefore, TPV is regarded as the more recyclable and environmentally friendly replacement to rubbers, especially to EPDM.

Most of the world's TPV elastomers are used for automotive purposes, including sealing strips, tubes and interiors. In developed countries, an automobile could contain four kilograms to five kilograms of TPV. In developing countries such as China and India, however, TPV consumption is usually less than two kilograms per vehicle.

Other important applications include appliances, medical, architecture and sports products.

Estimates and forecasts of the Asian TPV market and automotive applications through 2019 are provided in the following table.

TABLE 140

ASIAN THERMOPLASTIC VULCANIZATE MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	65.7	65.4	79.6	4.0
Others	37.0	36.8	42.9	3.1
Total	102.7	102.2	122.5	3.7

Source: BCC Research

Thermoplastic Vulcanizate Producers

Major TPV producers and developers include Teknor Apex (Sarlink), Advanced Elastomer Systems Limited (Santoprene, Vyram, Geolast), Dawn (Dawnprene), SK (Plastomer), ZEON (Zeotherm), DuPont (ETPV) and Down Corning (TPSiV).

AES's TPVs products include EPDM, NBR and NR types. Teknor Apex, Dawn and SK's TPVs are mainly EPDM types. ZEON and DuPont products are mainly ACM types. Down Corning's TPSiV is silicon rubber-based.

Asian Thermoplastic Polyurethane Market

Thermoplastic polyurethane (TPU) is the first commercialized TPE. It usually consists of rigid blocks formed by diphenyl-methane-diisocyanate (MDI) or toluene diisocyanate (TDI) reacting with chain extenders and soft blocks formed by MDI or TDI reacting with high-molecular polyols.

TPU has the advantages of high tensile strength, good toughness, abrasion resistance and oil resistance. Main applications include shoes materials, automobiles, tires, oil resistant hoses, medical products and waterproof membrane.

TPU can be processed by injection molding, extrusion and coating. Estimates and forecasts for the TPU market by processing method through 2019 are provided in the following table.

TABLE 141

ASIAN THERMOPLASTIC POLYURETHANE MARKET BY PROCESSING METHOD, THROUGH 2019
(THOUSAND METRIC TONS)

Processing Method	2013	2014	2019	CAGR% 2014–2019
Injection molding	54.1	55.3	68.8	4.5
Extrusion	42.8	44.9	54.2	3.8
Coating	24.5	25.8	30.5	3.4
Adhesive	16.6	17.2	21.0	4.1
Total	138.0	143.2	174.5	4.0

Source: BCC Research

Major TPU applications include shoe materials, automobiles, engineering, tires, oil-resistant hoses, medical products and waterproof membranes.

Estimates and forecasts of the TPU market by application through 2019 are provided in the following table.

TABLE 142

ASIAN THERMOPLASTIC POLYURETHANE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Footwear	40.0	41.5	50.3	3.9
Engineering	34.5	36.0	44.7	4.4
Adhesives	16.6	17.2	21.0	4.1
Automotive	15.2	15.3	17.1	2.2
Others	31.7	33.2	41.4	4.5
Total	138.0	143.2	174.5	4.0

Source: BCC Research

Thermoplastic Polyurethane Producers

Taiwan, Europe and the U.S. are the main TPU manufacturing regions. China’s TPU capacity has also quickly expanded in recent years.

There are more than 20 TPU manufacturers in Taiwan, with an annual capacity of more than 100,000 metric tons. Taiwanese TPU producers include Sunko Ink Co. Ltd., Coating Chemical Industry Co. Ltd. and Evermore Chemical Industry Co. Ltd.

China has TPU production facilities in Yantai, Baoding, Jinjiang and Nantong. The country consumes nearly 40% of the global TPU output. It also maintains more than 40% of global TPU capacity.

Major TPU producers and developers include Bayer, Huntsman, Lubrizol, BASF, Wanhua and Sunko.

Important acquisitions in the TPU industry in recent years include:

- Noven was purchased by Lubrizol. Noven has a $1 billion TPU market.
- The Taiwan-based Ure-Tech Co. was purchased by Bayer. Ure-Tech has a large share in the mainland China market.

China's TPU capacity has overtaken 40% of the global share, and it is still growing at a fast pace. It is expected that China will soon account for half of the world's TPU capacity.

Thermoplastic Polyurethane Technologies

Modifying TPI or MDI can improve the performances of TPU. For example, 1,4-phenylene diisocyanate (PPDI) is a solidification agent for high-performance TPU. PPDI-TPU has much higher tensile and tearing strengths compared to conventional TPU. When the temperature is higher than 120°C, the tensile and tearing strengths of PPDI-TPU can remain at approximately nine MPa and 10 $kN*m^{-1}$, respectively, which have almost no difference from when it is at 50°C, several times higher than conventional TPUs whose performance drops significantly at high temperature. This means PPDI-TPU has much better thermal resistance than common TPUs.

Other important TPU R&D involves developing new types of dimethyl-biphenyl diisocyanate (TOPI) TPU and 1,5-naphthalene diisocyanate (NDI) TPU.

Asian Thermoplastic Polyester Elastomer Market

Thermoplastic polyester elastomer (TPEE) is a blend of polyester and polyether. At low strain conditions, TPEE has higher modulus than most other TPEs. TPEE has much higher compression modulus and tensile modulus than TPU. In addition, TPEE has excellent low-temperature notched impact strength, abrasion resistance and fatigue resistance.

These advantages allow TPEE to be used in environments that require high performance. Major applications include automotive components, industrial products (e.g., hoses, belts) and appliances.

Estimates and forecasts for the TPEE market by application through 2019 are provided in the following table.

TABLE 143

ASIAN THERMOPLASTIC POLYESTER ELASTOMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	16.9	18.0	23.7	5.7
Industry (e.g., hoses, belts)	8.0	8.4	10.9	5.3
Appliances	4.2	4.4	5.5	4.6
Others	2.9	3.0	4.0	5.9
Total	32.0	33.8	44.1	5.5

Source: BCC Research

Thermoplastic Polyester Elastomer Suppliers

Major global TPEE producers and developers include DuPont, Lanxess (formerly DSM Elastomers) and LG. DuPont's product is marketed under the brand name Hytrel. LG's TPEE brand is Keyflex.

Other Thermoplastic Elastomers

Other TPEs include TPA, TPVC and MPR.

Polyamide Thermoplastic Elastomer

Polyamide thermoplastic elastomer (TPA) is blend of polyamide and polyester or polyether. Like polyamide, TPA has high tensile and toughness, as well as good abrasion resistance. It is also resistant to oil and heat, and it has very good processability.

The polyamide segment of TPA could be nylon 6, nylon 66 or nylon 12.

Nylon-12 TPA is regarded as a high-end TPA. It could be the most common commercialized TPA due to its excellent corrosion resistance and processability, and it is usually used to replace fluoroelastomers (FKM and FEPM) and silicone rubber.

The low-end TPAs such as Nylon-6 TPA also have very good market potential. Nylon-6 TPA can be made at a lower cost than TPU while having similar processability as TPEE.

Major TPA applications include wire and cable sheath in automobiles or appliances, footwear, medical tubes and resins modification.

Polyvinyl Chloride-Based Thermoplastic Elastomer

Polyvinyl chloride-based thermoplastic elastomer (TPVC) can be designed to have different hardness by adjusting the use of plasticizers. It has good coloring performance, and it is resistant to weathering, ozone, chemicals, scratching and heat. These advantages make it to good choice for sealing materials, as well as for wire and cable sheath for automobiles, appliances, industrial products, architecture, sports products, and medical products such as blood transfusion bags and tubes.

Melt Processable Rubber

Melt processable rubber (MPR) has excellent elasticity, and it is resistant to heat, oil and many chemicals. Its main performances would not change significantly even after repeated processing. Its resistance to flame, weathering and ozone is better than most of other TPEs.

Major MPR applications include sealing strips, sealing pads, wire and cable sheath, footwear and gloves.

Chapter 8

CHINESE ELASTOMER MARKET

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 8
CHINESE ELASTOMER MARKET

The chapter describes the details of Chinese elastomer market. It breaks the Chinese market down to segments at different levels:

- The Chinese elastomer market is broken down into two major segments: thermoplastic elastomers (TPEs) and thermoset elastomers (TSEs). Thermoset elastomers are those that irreversibly cure. Thermoplastic elastomers are pliable or moldable above specific temperatures and return to solid state upon cooling.

- The TSE segment is further divided to three sub-segments: natural rubber (NR), synthetic rubbers (SRs) and recycled rubbers (RRs). Recycled rubber is also known as reclaimed rubber.

- Third, the Synthetic Rubber sub-segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, EPR and Others. The EPR section includes EPM and EPDM. The Others section is comprised mostly of saturated rubbers that have relatively small volumes, including ethylene acrylate (AEM), fluoroelastomers (FKM), epichlorohydrin rubber (ECO), silicone rubber (e.g., fluorosilicone [FVMQ]), acrylic elastomer (ACM) and chlorosulfonated polyethylene (CSM).

- The TPE segment is further divided to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment “includes TPEs that have relatively small volumes of consumption, including TPA, TPVC and MPR.

- A TSE or TPE product may be further broken down into sections by sub-products.

Most segments, sub-segments and sections will be further divided or described by regions and applications. Capacities, technologies, industry trends and leading players will be also discussed.

The following table shows the estimates and forecasts of two major markets: TSEs and TPEs.

TABLE 144

CHINESE ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
Thermoset	9,634.9	10,224.2	13,428.4	5.6
Thermoplastic	1,430.3	1,539.5	2,330.0	8.6
Total	11,065.2	11,763.7	15,758.4	6.0

Source: BCC Research

TSE consumption will have stable growth in the next few years, whereas TPEs will experience much stronger growth.

THERMOSET ELASTOMERS

Thermoset elastomers, also known as rubbers, include natural rubber (NR) and synthetic rubbers (SRs). In some countries, the term *synthetic rubber* also includes some types of thermoplastic elastomers such as thermoplastic styrene elastomers (TPSs), also known as styrenic block copolymers (SBCs). This report excludes all thermoplastic elastomers from the Synthetic Rubber and Rubber categories. As a result, SBCs are put in the Thermoplastic Elastomer category.

Recycled rubber (RR), also known as reclaimed rubber, maintains a significant market share in countries such as China. This report breaks the thermoset elastomers market down to three segments: natural rubbers, synthetic rubbers and recycled rubbers.

Estimates and forecasts of the Chinese rubber market through 2019 are provided in the following table.

TABLE 145

CHINESE THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
NR	4,250.0	4,520.0	5,750.0	4.9
SRs	3,593.9	3,787.8	4,990.6	5.7
RRs	1,791.0	1,916.3	2,687.8	7.0
Total	9,634.9	10,224.1	13,428.4	5.6

Source: BCC Research

Recycled rubbers include recycled natural rubber (RNR) and recycled synthetic rubber (RSR). The estimates and forecasts of the Chinese recycled rubber market by product are shown in the following table.

TABLE 146

CHINESE RECYCLED RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SR	1,194.3	1,279.1	1,802.4	7.1
NR	596.7	637.2	885.4	6.8
Total	1,791.0	1,916.3	2,687.8	7.0

Source: BCC Research

According to experts, 3.0 metric tons of recycled natural rubber can be used to replace one metric ton of natural rubber, and 1.5 to 2.0 metric tons of recycled synthetic rubber can replace one metric ton of synthetic rubber. Therefore, this report assumes 3.0 metric tons of recycled natural rubber is equals one metric ton of natural rubber, and 1.75 metric tons of recycled synthetic rubber equals one metric ton of synthetic rubber. The numbers of recycled rubber volume in the previous table have been converted into *metric ton natural rubber equivalent* and *metric ton recycled rubber equivalent*.

If RNR is put into the NR segment and RSR is put into the SRs segment, the estimates and forecasts of the Chinese thermoset elastomer market will resemble those shown in the following table.

TABLE 147

CHINESE THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
NR*	4,846.7	5,157.2	6,635.4	5.2
SR*	4,788.2	5,066.9	6,792.9	6.0
Total	9,634.9	10,224.1	13,428.4	5.6

*NR and SR include recycled rubber volume.

Source: BCC Research

Synthetic rubbers include IR, BR, SBR, NBR, CR, IIR, EPM/EPDM, ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

NATURAL RUBBERS

Natural Rubbers, Compounded Rubbers and China

In this report, the Natural Rubber segment includes natural rubber and compounded rubbers.

Natural rubber consists of polymers of organic compound isoprene with impurities of other organic compounds plus water. Commercial natural rubber include standard rubber and ribbed smoked sheet (RSS).

Compounded rubbers usually consist of 95% to 99.5% natural rubbers, which are mostly polyisoprene, with additional chemicals such as stearic acid, styrene butadiene rubber, synthetic polyisoprene (IR), butadiene rubber (BR), carbon black, peptizers and nihil album. In this report, the volume of compounded rubbers does not include additional chemicals.

Nearly 90% of the world's natural rubbers are produced in Southeast Asia countries such as Thailand, Malaysia, Indonesia and Vietnam. In 2013, the global natural rubber acreage was nearly 13.1 million hectares, with a total output of 12.4 million metric tons, up 3.8% from the previous year. Asia produced 11.4 million metric tons, maintaining 92% of the global production.

BCC Research estimates the global consumption of natural rubbers was approximately 11.52 million metric tons in 2013. This number is a slightly larger than data provided by other organizations. This is because the BCC Research report counts in some international trade and consumption going through gray channels. For example, Chinese companies buy 100,000 to 300,000 metric tons of natural rubber through border trade from Vietnam, Cambodia and Laos per year without paying import taxes to the government.

China, the world largest tires manufacturing country, consumes more than 40% of the world's natural rubbers. Trends in this market are the most important indicators for the global natural rubber industry.

By the end of 2013, China had 1.1 million hectares of natural rubber acreage, producing 0.85 million metric tons of natural rubber that year.

China's imports of natural rubbers and compounded rubbers in 2013 were 2.47 million metric tons and 1.54 million metric tons, respectively. Assuming the imported compounded rubbers use on average 96% natural rubber, the natural rubber content amounted 1.48 million metric tons. In addition, border trade of natural rubbers, which did not usually pay import taxes, totaled roughly 200,000 metric tons. In the same period, China's export of natural rubbers and compounded rubbers totaled 30,000 metric tons.

Based on this data and converting the import numbers into solid volume, China's apparent consumption of natural rubbers and compounded rubbers was nearly 4.25 million metric tons in 2013, maintaining approximately 37% of the global consumption of 11.52 million metric tons.

Compounded rubbers are products of distorted tariff systems. Most are produced because China levies different tax rates on natural rubbers and compounded rubbers.

China sets the import tariffs for ribbed smoked rubber sheets (RSS) at 20% of the value and capped at 1,200 yuan per metric ton. For technically specified natural rubber (TSNR), also known as standard rubber, the tax rate was lowered to the same level of RSS since 2013.

For compounded rubbers imported from Southeast Asia, China reduced the import tariffs to zero in 2009. This encourages rapid growth of compounded rubbers imports since that time.

There is, however, lack of standards for compounded rubbers in China. Thus, compounded rubbers are rarely used for high-performance tires such as radial tires. Some experts believe most of the compounded rubber capacity and international trades are unnecessary and will vanish once China sets the same import taxes on natural rubbers and compounded rubbers.

Natural Rubber Consumption

China, Europe, India, the U.S. and Japan are main natural rubber-consuming countries. Major natural rubber producers such as Indonesia, Thailand, Malaysia and Vietnam also see growing natural rubbers consumption, as the global industrial chain has moved some of the capacity of rubber products to these regions.

Approximately two-thirds of the growth of global natural rubber consumption will be from China in the next five years.

SYNTHETIC RUBBERS

Synthetic rubbers are thermoset elastomers mainly produced from petroleum byproducts. This segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, ERP and Others. The ERP section includes EPM and EPDM. The Others section is mostly comprised of saturated rubbers that have relatively small volumes, including ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

Estimates and forecasts of the Chinese synthetic rubbers are provided in the following table.

TABLE 148

CHINESE SYNTHETIC RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SBR	1,315.0	1,368.2	1,683.7	4.2
BR	1,060.0	1,124.7	1,512.2	6.1
IIR	388.0	417.1	598.8	7.5
EPR	215.0	232.0	339.3	7.9

NBR	162.0	172.0	232.4	6.2
IR	92.0	98.6	139.6	7.2
CR	65.0	67.6	82.2	4.0
Others	296.9	307.6	402.4	5.5
Total	3,593.9	3,787.8	4,990.6	5.7

Source: BCC Research

SBR will remain the largest segment in the following five years, but its market share will decline.

Chinese Styrene Butadiene Rubber Market

Styrene butadiene is a copolymer of styrene and butadiene. It comprises the world's largest synthetic rubber family. Major types include emulsion-polymerized styrene butadiene rubber (ESBR) and solution polymerized styrene butadiene rubber (SSBR).

Estimates and forecasts of Chinese SBR consumption by product through 2019 are provided in the following table.

TABLE 149

CHINESE STYRENE BUTADIENE RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
ESBR	1,205.0	1,244.8	1,464.2	3.3
SSBR	110.0	123.4	219.5	12.2
Total	1,315.0	1,368.2	1,683.7	4.2

Source: BCC Research

ESBR will continue to hold most of the market share, but SSBR will have a much faster growth.

In China, oil-extended ESBR accounts for approximately 40% of total ESBR consumption. Oil-extended ESBR has lower heat generation, better processability and better flex resistance compared to the non-oil-extended version. When used for tread, oil-extended ESBR has better traction performance and abrasion resistance. Oil-extended ESBR is mostly used for making tire treads and side walls.

Major SBR applications include tires, automotive, conveyer belts, hoses, tapes, footwear, medical products and modifiers.

Most SBRs are used for tire manufacturing. Estimates and forecasts of Chinese SBR consumption by major applications through 2019 are provided in the following table.

TABLE 150

CHINESE STYRENE BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	973.1	1,012.5	1,296.4	5.1
Automotive	30.9	33.7	49.1	7.8
Others	311.0	322.0	338.2	1.0
Total	1,315.0	1,368.2	1,683.6	4.2

Source: BCC Research

In tire applications, SBR is mostly used for treads, side walls and carcasses. SBR is widely used for tires in passenger cars, tractors and motorcycles. SBR is rarely used for heavy-duty tires.

In automotive applications, SBR is used for making hoses, V-belts, synchronous belts, O rings, sealing strips and shock-reducing rubber.

Other applications include footwear, conveyer belts, hoses, tapes, medical products and modifiers.

Styrene Butadiene Rubber Producers

- *Emulsion-Polymerized Styrene Butadiene Rubber Producers*

Leading global ESBR manufacturers include China National Petroleum Corporation (CNPC), Kumho Tires and Sinopec. These three companies produce nearly one-third of the world’s capacity.

Capacities of leading ESBR manufacturers and their market shares are provided in the following table.

TABLE 151

LEADING CHINESE EMULSION-POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS/%)

Company	Capacity	Percent
CNPC	500	36.2
Sinopec	450	32.6
Shenhua	180	13.0
Zhechen	100	7.2
Lugang	100	7.2
Bridgestone Huizhou	50	3.6
Total	1,380	99.8

Source: BCC Research

CNPC's three sub-companies have four ESBR facilities, with a total capacity of 500,000 metric tons per annum.

Sinopec has ESBR production facilities in three locations, with a total capacity of 450,000 metric tons per annum.

- *Solution Polymerized Styrene Butadiene Rubber Producers*

Leading SSBR manufacturers include Styron, Firestone, Michelin, Japan Synthetic Rubber and Goodyear. These four companies produce more than 40% of the world's capacity. Firestone was purchased by Bridgestone and now is part of Bridgestone.

Capacities of leading SSBR manufacturers and their market shares are provided in the following table.

TABLE 152

LEADING CHINESE SOLUTION POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013
(MILLION METRIC TONS)

Company	Capacity	Product
CNPC	100	SSBR/SBS
Sinopec	90	SSBR/BR
Shuanghui Rubber	20	SSBR/BR/SBS
World total	21	

Source: BCC Research

CNPC's subsidiary Dushanzi Petrochemical Co. has a SSBR/SBS plant with 100,000 metric tons of SSBR and 80,000 metric tons of SBS per annum.

Sinopec has three subsidiaries producing SSBR. Sinopec Shanghai Gaoqiao Co. has a plant with a total capacity of 100,000 metric tons per annum: 60,000 metric tons of SSBR and 40,000 metric tons of low-cis BR. Sinopec Beijing Yanshan Co (Sinopec Yanshan) has an annual capacity of 30,000 metric tons of SSBR. Sinopec Maoming has an annual capacity of 30,000 metric tons. Sinopec Yanshan, however, has changed the facility to produce SBC.

In addition to this capacity, Shandong Huamao New Materials Co. Ltd., another Chinese company, has completed a SSBR facility with an annual capacity of 100,000 metric tons, but this facility is not in production due to slow marketing progress.

Styrene Butadiene Rubber Technologies

Leading players in SBR R&D include Goodyear, Bridgestone, Japan Synthetic Rubber Co. Inc., BASF, Dow Chemical and ZEON. They license their manufacturing technologies and patents to manufacturers in Asia, South America and Africa.

Technological trends of emulsion-polymerized styrene butadiene rubber include:

- Higher monomer conversion percentage.
- New functional monomers for improving rubber performance.
- New types of emulsifiers and conditioning agents.
- Environmentally friendly termination agents.
- Powder manufacturing method.

For SSBR production, most manufacturers use manufacturing technologies based on Phillips' batch polymerization method. Others use continuous polymerization process based on the Firestone method. Firestone is now part of Bridgestone.

Technological SSBR innovations mainly focus on microstructure control. An example the development of a functional SSBR with high ethylene content and moderate and controllable styrene content by using new types of multifunctional initiators, couplers and conditioning agents.

Chinese Butadiene Rubber Market

Butadiene rubber is an elastomer polymerized by 1,3-butadiene monomers, which is a conjugated diene with the formula C_4H_6.

BR is mostly used for making tires. It is also used as an impact-resistance modifier in making high-impact polystyrene (HIPS) and acrylonitrile butadiene styrene (ABS).

Estimates and forecasts of Chinese BR consumption by major applications through 2019 are provided in the following table.

TABLE 153

CHINESE BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	816.2	866.0	1,170.4	6.2
HIPS	108.1	114.7	153.5	6.0
ABS	31.8	33.8	45.4	6.1
Others	103.9	110.2	142.9	5.3
Total	1,060.0	1,124.7	1,512.2	6.1

Source: BCC Research

In tire applications, BR is mostly used for making treads and side walls. Nd-BR is a promising type due to its advantages such as high tensile strength, low heat generation, low hysteresis loss, excellent flex resistance and wet traction, and low rolling resistance.

As an impact-resistance modifier for HIPS, the additive BR equals 5% to 8% of HIPS in terms of volume.

As a modifier for making ABS, one kilogram of ABS is added with 0.1 kilograms to 0.2 kilograms BR.

BR is also used for making hoses, belts, sports products, automotive parts and other products.

Butadiene Rubber Producers

Major BR producers include Sinopec, Lanxess, Kumho, Michelin, Goodyear, UBE, Eni, CNPC and Sibur. Sinopec and CNPC have a total capacity of 710,000 metric tons of BR.

Butadiene Rubber Technologies

The leading global players in BR R&D include UBE, Goodyear, Bridgestone, Japan Synthetic Rubber and Lanxess.

- *Ti-BR:* The only large Ti-BR producer is the Russia-based Sibur. This technology could be phased out in the future.
- *Co-BR:* Technological innovations focus on making syndiotactic 1,2 polybutadiene with different crystallinity and melting temperatures.
- *Ni-BR:* The focus is on high cis-hyperbranched BR.
- *Li-BR:* The focus is developing low-cis BR (LCBR) with different ethylene content.

- *Nd-BR:* The focuses include advanced initiating systems and related polymerization processes, as well as chain-end modification technologies.

- *Others:* Other important trends include making high ethylene content BR by using Mo or Fe initiating systems.

Chinese Nitrile Rubber Market

Nitrile rubber, also known as acrylonitrile butadiene rubber, Buna-N and Perbunan, is a copolymer of acrylonitrile (ACN) and butadiene. Major types include hydrogenated nitrile rubbers (HNBR), powder nitrile rubbers (PNBR) and carboxylated nitrile rubbers (XNBR).

Estimates and forecasts of Chinese NBR consumption by major products through 2019 are provided in the following table.

TABLE 154

CHINESE NITRILE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
PNBR	13.0	13.8	18.6	6.2
HNBR	12.6	13.8	21.8	9.6
Others	136.4	144.4	192.0	5.8
Total	162.0	172.0	232.4	6.2

Source: BCC Research

Major NBR products include hoses, belts, wire and cable, O rings, adhesives, sealants, footwear and molded products. Many of these products are used in automobiles.

More than 60% of Chinese HNBR is used for automotive purpose. Estimates and forecasts of Chinese HNBR consumption and automotive applications through 2019 are provided in the following table.

TABLE 155

CHINESE HYDROGENATED NITRILE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	7.7	8.4	13.4	9.8
Others	4.9	5.4	8.4	9.2
Total	12.6	13.8	21.8	9.6

Source: BCC Research

In China, an automobile usually consumes 0.3 kilograms to 0.6 kilograms of HNBR.

Nitrile Rubber Producers

The leading global players of NBR production and R&D include Lanxess, ZEON, Bayer, Sinopec, Sibur, JSR and Polimeri. ZEON's NBR trade name is Nipol and Lanxess' NBR is marketed under the trade name Krynac.

Sinopec is the largest producer in China, with an annual capacity of 70,000 metric tons.

Nitrile Rubber Technologies

The leading global players of NBR R&D include Lanxess, Bayer, ZEON and Eni.

Advances in NBR R&D include polymerization formulas, polymerization methods, automatic control technologies and new grades of products.

Focus is placed on high-efficiency and environmentally friendly polymerization formulas.

New products are specialized and differentiated NBR for different applications. They include chain-end NBR, carboxylated nitrile rubber (XNBR), fast-vulcanized NBR, hydrogenate NBR (HNBR), third monomer-copolymerized NBR and powder NBR.

Chinese Isobutylene Isoprene Rubber Market

Isobutylene isoprene rubber (IIR), also known as butyl rubber, is a copolymer of isobutylene and isoprene. IIR has excellent impermeability and good flex properties. Its air permeability is only one-seventh of natural rubber and one-fifth of styrene butadiene rubber. Its steam permeability is only 1/200 of natural rubber and 1/140 of styrene butadiene rubber.

Most IIRs are halogenated. Halogenated IIRs (HIIRs) include chloro isobutylene isoprene rubber (CIIR) and bromo isobutylene isoprene rubber (BIIR).

Estimates and forecasts of Chinese IIR consumption through 2019 are provided in the following table.

TABLE 156

CHINESE ISOBUTYLENE ISOPRENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
HIIR	294.9	319.1	458.1	7.5
Others	93.1	98.0	140.7	7.5
Total	388.0	417.1	598.8	7.5

Source: BCC Research

Major IIR products include tires, electric insulation materials, medical bottle plugs, gas masks and sealing materials.

Roughly 80% of Chinese HIIR is used for tire purposes. Estimates and forecasts of Chinese HIIR consumption and automotive applications through 2019 are provided in the following table.

TABLE 157

CHINESE HALOGENATED ISOBUTYLENE ISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014-2019
Tires	249.8	271.9	391.4	7.6
Others	45.1	47.2	66.7	7.2
Total	294.9	319.1	458.1	7.5

Source: BCC Research

In tire applications, IIR is mostly used for making inner liners and inner tubes.

Isobutylene Isoprene Rubber Producers

Exxon Mobil and Lanxess are the world’s two largest IIR producers. Exxon Mobil produces nearly half of the world’s capacity with its subsidiaries and joint ventures.

Sinopec is the only IIR producer in China. Its subsidiary Sinopec Beijing Yanshan Company put its new IIR facility into trial production on December 5, 2013. The new facility has an

annual capacity of 90,000 metric tons of HIIR. The company's other facility has a capacity of 45,000 metric tons of IIR, so it has a total capacity of 135,000 metric tons of IIR per year.

Isobutylene Isoprene Rubber Technologies

The leading global players for IIR R&D include Exxon Mobil, Lanxess and Bayer.

IIR R&D mainly focuses on advanced initiating systems, high polymerization temperature, improved reactors and new product development.

Chinese Ethylene Propylene Rubber Market

Ethylene propylene rubber includes ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM). EPR is resistant to heat, oxidation, ozone, steam, water, chemicals and weathering. It can be used at temperatures from -55°C to 150°C. At 120°C EPR can also be used for long periods. Above 120°C, the aging of EPR could be accelerated, and the service life will be shortened. EPR can be used under even worse conditions by oxide crosslinking.

EPR has excellent electrical insulation properties. It has low density (0.87), and it can be filled with oil and other materials to lower costs. For high-Mooney viscosity EPR, filling with other materials does not reduce EPR's mechanical properties to a significant degree.

The disadvantages of EPR include poor oil resistance and long cure time, which is three- to four-times longer than most other synthetic rubbers. In addition, EPR has low adhesiveness to itself and other materials, which makes it difficult to process.

Estimates and forecasts of Chinese EPR consumption by product through 2019 are provided in the following table.

TABLE 158

CHINESE ETHYLENE PROPYLENE RUBBER MARKET BY PRODUCT THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
EPDM	182.8	197.2	289.4	8.0
EPM	32.3	34.8	49.9	7.5
Total	215.1	232.0	339.3	7.9

Source: BCC Research

EPR is used for automotive, blend modification, architecture, wire and cable, and tires. Estimates and forecasts of Chinese EPR consumption by application through 2019 are provided in the following table.

TABLE 159

CHINESE ETHYLENE PROPYLENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	117.6	128.2	193.5	8.6
Blend modifications	19.4	20.9	29.5	7.1
Wire and cable	17.2	18.6	26.5	7.3
Architecture	10.8	11.6	16.6	7.4
Tires	10.8	11.6	16.6	7.4
Others	39.4	41.1	56.6	6.6
Total	215.0	232.0	339.3	7.9

Source: BCC Research

EPR is the most widely used automotive rubber (except for tire applications). It is used for making sealing strips for automotive doors and windows, ventilation pipes of air conditioners, seal components and hoses.

In blend modification applications, EPR is used to improve other rubbers or polymers' resistance to heat, oxidation, ozone, steam and low temperatures.

In architectural applications, EPR is used for waterproof rolls, sealing strips and sports tracks.

Ethylene Propylene Rubber Producers

Major EPR producers include Exxon Mobil, Mistsui Chemicals, Lanxess, Dow Chemical, Crompton, DuPont, Herdillia, Kumho, Mitsui Chemicals, Versalis (former Polimeri Europa) and Sumitomo Chemical.

Sinopec Jilin Company is the only EPDM producer in China. Another new entrant will be Shanghai Sinopec Mitsui Elastomers Co. Ltd. (SSME), a 50:50 joint venture of Sinopec and Mitsui Chemicals. SSME's EPDM plant, which was completed May 2014 and put into production in November 2014, has an annual capacity of 75,000 metric tons per year.

Ethylene Propylene Rubber Technology Research and Development

The leading global players for EPR R&D include Exxon Mobil, Lanxess, Mistsui Chemicals and Bayer. The solution polymerization method dominates global EPR production.

EPR R&D mainly focuses on advanced initiating systems and polarization modification:

- The initiating systems have moved from V and Ti systems of the Ziegler-Natta series to metallocene and low-valence homogeneous systems.

- Polarization modification is usually used to improve EPR's compatibility to other rubbers and materials. Examples include chloration, sulfonation, and blending modifications with organic silicon and nylon.

Chinese Polyisoprene Rubber Markets

Polyisoprene rubber (IR) is a synthetic rubber with similar properties to natural rubber, so in some countries, it is called *synthetic natural rubber*. It has better water resistance and electrical insulation than natural rubber, but the strength, adhesiveness and processability of raw rubber and tearing strength and fatigue resistance of cured rubber are usually slightly lower than natural rubber.

Estimates and forecasts of Chinese IR consumption by application through 2019 are provided in the following table.

TABLE 160

CHINESE POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	73.6	78.9	111.4	7.1
Machinery	6.0	6.4	9.1	7.3
Footwear	4.6	4.9	6.9	7.1
Adhesives and sealants	3.7	3.9	5.7	7.9
Others	4.1	4.4	6.5	8.1
Total	92.0	98.5	139.6	7.2

Source: BCC Research

China expanded its IR capacity to 215,000 metric tons by 2013, but its domestic demand won't provide enough market for the capacity. The industry will fall into severe overcapacity, and China will largely reduce or stop its IR imports from Russia.

For tire applications, IR is used in treads, side walls, carcasses, inner liners, belt plies and tire shoulders.

Synthetic Polyisoprene Producers

Major global IR producers include NKNH, Sibur (Togliattikauchuk), Goodyear and Sinopec.

Leading Chinese producers and their capacities are provided in the following table.

TABLE 161

LEADING CHINESE SYNTHETIC POLYISOPRENE MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity
Qingdao Yikesi	70
Panjin Zhenao	50
Zibo Luhua	50
TPI	30
Maoming Luhua	15
Total	215

Source: BCC Research

China did not produce IR before 2010. Since then, five Chinese companies have been actively set up and expanded their IR capacities, reaching a total of 215,000 metric tons per year by 2013. It is estimated that China will soon surpass Russia to become the world's largest IR-producing country.

Synthetic Polyisoprene Technologies

The leading global players for IR R&D include Goodyear, Bayer, Japan Synthetic Rubber and Kuraray.

Technological trends of IR include:

- *Li-IR:* Cis contents could be increased by introducing active components into lithium initiator. For example, cis content is increased to more than 98% by using n-BuLi with 1, 3-dibromobenzene and triphenylamine

- *Ti-IR:* The most popular initiator could be Ti-based initiators. An example is $TiCl_4$-AIR_3 initiator, which could be added with synergistic-effect third component for improving system activity. Chinese companies use Ti-based initiators to produce Trans-1, 4 polyisoprene (TPI), which has been successfully used for replacing natural rubbers in heavy-duty tires.

- *Nd-IR:* Many companies engage in the innovation and optimization of Nd-based initiating system and polymerization process.

Chinese Chloroprene Rubber Markets

Chloroprene rubber (CR), also known as polychloroprene or Neoprene, the trade name given by DuPont, is a synthetic rubber produced by polymerization of chloroprene. It has good chemical stability and maintains flexibility over a wide temperature range. CR has

good mechanical properties and is resistant to oil, heat, flame, sunlight, ozone, acid, alkali and chemicals.

The disadvantages of CR include relatively bad low-temperature resistance and poor electrical insulation. In addition, CR has low storage stability. The so-called *bin cure* occurs in storage of raw CR rubber, which increases Mooney viscosity and makes the rubber harder.

Major CR applications include adhesives for footwear and architecture, industrial products (e.g., hoses and belts, sealing strips and pads, white-wall tires, cycle tires), and wire and cable.

Estimates and forecasts of the Chinese CR market by application are provided in the following table.

TABLE 162

CHINESE CHLOROPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Adhesives	38.3	39.9	47.6	3.6
Industrial products	18.9	19.6	24.6	4.6
Wire and cable	7.8	8.1	10.0	4.3
Total	65.0	67.6	82.2	4.0

Source: BCC Research

Chloroprene Rubber Producers

Major global CR producers include Denka, DuPont and Lanxess. Global CR capacity reached its historical height of 800,000 metric tons in the 1980s. From the early 1990s and mid-2000s, however, CR was gradually replaced by EPR and other rubbers, especially in automotive applications, and capacity dropped significantly. After 2005, CR demands from Asia (especially China) re-grew due to the booming automobile and real estate markets there. It’s estimated that global CR capacity will continue slow growth in the following five years.

Leading Chinese CR manufacturers and their capacities can be found in the following table.

TABLE 163

LEADING CHLOROPRENE RUBBER MANUFACTURERS BY CAPACITY, 2013 (THOUSAND METRIC TONS)

Company	Capacity
Shanxi Synthetic Rubber	65.0
Chongqing Changshou	30.0
Total	95.0

Source: BCC Research

Important expansion in the next few years will be from China. This includes:

- Chongqing Changshou will increase 40,000 metric tons of annual capacity.
- Sichuan Changning will set up a new facility with the capacity of 50,000 metric tons per year.
- A facility located in Dongyinggang, China will have a capacity of 20,000 metric tons per year.
- A plant in Inner Mongolia will have the capacity of 20,000 metric tons per year.

Chloroprene Rubber Technologies

The leading global players for CR R&D include Denka, DuPont, Bayer and Lanxess.

The raw materials of CR are toxic and cause great damage to the environment, so CR has higher environmental costs than most other synthetic rubbers. In addition, the manufacturing process is relatively long and costly, so CR has been gradually replaced by other rubbers.

CR is still widely used in adhesives. R&D currently focuses on graft modification of solvent-type CR. Graft modification improves the bonding ability between CR and some types of advanced materials. Powder technology is another direction for CR innovations.

Chinese Markets for Other Synthetic Rubbers

Other important synthetic rubbers include ECO, AEM, FKM, silicone rubber (SIR) and ACM. In this report, silicone rubber includes fluorosilicone rubber (FVMQ).

In China, more than one-third of these rubbers are used for automotive purposes (except for tire applications). Estimates and forecasts for some rubbers used for automotive purposes are provided in the following table.

TABLE 164

CHINESE OTHER SYNTHETIC RUBBER AUTOMOTIVE APPLICATIONS BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
FKM	18.5	20.2	31.8	9.5
SIR	12.3	13.5	22.0	10.3
ECO	10.8	11.8	19.6	10.7
ACM	6.1	6.7	12.2	12.7
AEM	4.6	5.0	9.8	14.4
Total	52.3	57.2	95.4	10.8

Source: BCC Research

Fluorocarbon Rubber

Fluorocarbon (FKM) is resistant to high temperatures, ozone, oxygen, oil and many other chemicals. Under dynamic conditions, the lowest service temperature is approximately 15°C (5°F). Gas permeability is very low and similar to that of butyl rubber. Special FKM compounds exhibit an improved resistance to acids and fuels.

Globally, nearly 60% of FKM is used for the automotive industry. Major applications include fuel hoses, gas pipes, fuel pump and jet device seals, valve stem seals, dynamic seals, piston seals, crankshaft oil seals, universal joint gaskets, O rings and air conditioning compressor seals. An automobile may use 0.2 kilograms to 1.6 kilograms of FKM.

Epichlorohydrin Rubber

Epichlorohydrin (ECO) is a copolymer or homopolymer with similar properties to nitrile rubber, but with better oil and heat resistance. It has a low gas permeability and better low-temperature flexibility than NBR. It is resistant to acids, alkalis and ozone. Disadvantages of ECO include poor compression set and corrosive effect on metals.

ECO was first developed by two U.S. companies—Goodrich and Hercules—in the 1960s. Goodrich produced ECO under the trade name Hydrin, and Hercules produced ECO under the trade name Herclor. ZEON entered the ECO industry in the 1970s under an agreement with Hercules and another Japanese company. Hydrin currently belongs to ZEON.

ZEON’s Hydrin polymers are used for fuel oil-resistant applications for automobile gaskets, hoses and diaphragms, as well as for printer rolls and anti-static applications.

Fluorosilicone Rubber

Fluorosilicone rubber (FVMQ) contains trifluoropropyl groups next to the methyl groups. The mechanical and physical properties are similar to VMQ. FVMQ, however, offers improved fuel and mineral oil resistance, but poor hot air resistance when compared with silicone rubber (VMQ).

THERMOPLASTIC ELASTOMERS

TPEs include SBC (also known as TPS), TPO, TPV, TPEE, TPU, TPA, TPVC and MPR.

ADVANTAGES

In many applications, TPEs are advanced and better replacements than TSEs. Advantages of TPEs against TSEs include:

- TPEs have simpler manufacturing methods for making end products. For example, making automobile rubber seal strips from ethylene propylene diene monomer (EPDM) requires three steps: mixed compounding, molding and high-temperature vulcanization. Making the product from TPE only requires one direct molding step. Simpler manufacturing methods largely increase production efficiency.

- TPEs save energy. Processing $1,000 worth of synthetic rubber usually consumes more than one metric ton of standard coal equivalent. According to an automotive manufacturer, the three steps for making one kilogram of automobile rubber seal strips of EPDM could consume a total 2.2 kilowatts to 2.3 kilowatts. The single molding step for making automobile rubber seal strips of TPE usually consumes no more than 0.6 kilowatts per kilogram. The TPE route reduces energy consumption by nearly 75%. Likewise, compared to making automobile dustproof cover of chloroprene rubber (CR), the TPE route could reduce energy consumption b 70% to 80%.

- TPE is recyclable There are more than 20 million metric tons of waste rubbers per year globally. TPE is more recyclable than synthetic rubbers. Therefore, synthetic rubber replacement by TPE is environmentally friendly.

THERMOPLASTIC ELASTOMERS PROUCTS

This report divides the TPEs market to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs that have relatively small volumes of consumption, including TPA, TPVC and MPR.

Chinese Styrenic Block Copolymer Market

Styrenic block copolymer (SBC) is the most widely used thermoplastic elastomer. Major SBC types include SBS, SEBS, SIS and SEPS.

Hydrogenated SBCs, including styrene ethylene butylene styrene (SEBS) and styrene ethylene propylene styrene (SEPS), are relatively new SBC types. They have advantages such as better aging resistance and tensile properties than un-hydrogenated SBCs.

Estimates and forecasts of the Chinese SBC market by product can be found in the following table.

TABLE 165

CHINESE STYRENIC BLOCK COPOLYMER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SBS	641.0	677.1	914.1	6.2
SEBS	57.0	66.0	105.0	9.7
SIS	52.0	57.0	88.0	9.1
SEPS	20.0	23.0	42.0	12.8
Total	770.0	823.1	1,149.1	6.9

Source: BCC Research

In 2013, China’s SBS capacity was nearly 880,000 metric tons, with roughly 620,000 metric tons of output. Import was 43,000 metric tons, and export was roughly 20,000 metric tons.

In 2013, China’s SIS capacity reached 170,000 metric tons, producing more than 40% of the global share, but demand was only 52,000 metric tons. The industry has fallen into severe overcapacity. Some manufacturers have delayed their SIS projects or turned toward producing other products such as SBS.

In 2013, China’s SBES capacity was 135,000 metric tons, producing more than one-third of the global capacity. Demand was only 57,000 metric tons.

Kraton (U.S.) and Kuraray (U.S. and Japan) dominate the world’s production of SEPS, with a total capacity of roughly 140,000 metric tons per year. China’s consumption of SEPS, which was roughly 20,000 metric tons in 2013, was imported from the U.S. and Japan. The China-based Baling Petrochemical Corp., a subsidiary of Sinopec, is working on a project with an annual capacity of 10,000 metric tons of SBPS, which is expected to be put into production by 2016.

Main applications include adhesives and sealants, asphalt modifiers, polymer modifiers, viscosity index (VI) improvers and footwear. Estimates and forecasts of the Chinese SBC market by application are listed in the following table.

TABLE 166

CHINESE STYRENIC BLOCK COPOLYMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Footwear	315.7	337.5	459.6	6.4
Asphalt modifiers	192.5	205.8	294.2	7.4
Adhesives and sealants	115.5	123.5	174.7	7.2
Polymer modifiers	69.3	74.1	104.6	7.1
Viscosity index improvers	7.7	8.2	11.7	7.4
Others	69.3	74.1	104.3	7.1
Total	770.0	823.2	1,149.1	6.9

Source: BCC Research

Styrenic Block Copolymers Producers

Major global SBC producers include Sinopec, Kraton and the LCY Group.

Important SBC facilities and their capacities in China are provided in the following table.

TABLE 167

LEADING CHINESE STYRENIC BLOCK COPOLYMER MANUFACTURERS BY CAPACITY, 2013
(MILLION METRIC TONS)

Company	Capacity	Products
Sinopec, China	450	SBS/SIS/SEBS
LCY, China	300	--
CNPC, China	100	SBS/SIS/SEBS
TSRC, China	50	--
Other Chinese companies	300	--
Total	1,200	--

Source: BCC Research

Styrenic Block Copolymer Technologies

The leading global players for SBC R&D include Kraton, BASF and Japan Synthetic Rubbers.

SBC R&D currently focuses on:

- New initiating system for lowing costs.
- Diversification and functional SBC performances.
- Low-pressure hydrogenation technologies.
- Radiation SBC curing technologies.
- Energy-saving technologies.
- Reversible addition-fragmentation chain transfer (RAFT) polymerization technology for making SBC with excellent heat resistance and solvent resistance.

Chinese Thermoplastic Polyolefin Market

Thermoplastic polyolefin (TPO), also known as polyolefin elastomer (POE), is a blend of polyolefins and rubbers. The rubber contents are usually EPDM, NBR, IIR or natural rubber. Polyolefins are usually PP or PE. The most widely used TPO is blended by EPDM and PP.

Through manufacturing methods, TPO can be divided by reactor-made thermoplastic polyolefin (RTPO) and blended thermoplastic polyolefin (BTPO).

Most of the world's TPO elastomers are used for automotive purposes, including panels, buffer capsules, tubes, gear covers, sealing materials and interior materials. Other important applications include appliances, machinery, medical, architecture and sports products.

Important TPO brands include Exact by ExxonMobil Chemical and Engage by Dow Chemical.

Estimates and forecasts of the Chinese TPO market and automotive applications through 2019 are provided in the following table.

TABLE 168

CHINESE THERMOPLASTIC POLYOLEFIN MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	143.5	156.5	279.6	12.3
Others	77.3	84.3	147.3	11.8
Total	220.8	240.8	426.9	12.1

Source: BCC Research

Chinese Thermoplastic Vulcanizate Market

Thermoplastic vulcanizate (TPV) can be perceived as a vulcanized and upgraded version of TPO. TPV has excellent elasticity and compression deformation resistance. It has

environment and aging resistance similar to EPDM. In addition, it has oil and solvent resistance similar to chloroprene rubber. Therefore, TPV is regarded as the more recyclable and environmentally friendly replacement to rubbers, especially to EPDM.

Most of the world's TPV elastomers are currently used for automotive purposes. It is perfect for sealing strips, tubes and interiors. In developed countries, an automobile could include four kilograms to five kilograms of TPV. In developing countries such as China and India, however, TPV consumption is usually less than two kilograms per vehicle.

Other important applications include appliances, medical, architecture and sports products.

Estimates and forecasts of the Chinese TPV market and automotive applications through 2019 are provided in the following table.

TABLE 169

CHINESE THERMOPLASTIC VULCANIZATE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	53.0	57.8	108.5	13.4
Others	35.3	38.5	69.4	12.5
Total	88.3	96.3	177.9	13.1

Source: BCC Research

Thermoplastic Vulcanizate Producers

Major TPV producers and developers include Teknor Apex (Sarlink), Advanced Elastomer Systems Limited (Santoprene, Vyram, Geolast), Dawn (Dawnprene), SK (Plastomer), ZEON (Zeotherm), DuPont (ETPV) and Down Corning (TPSiV).

AES's TPVs products include EPDM, NBR and NR types. Teknor Apex, Dawn and SK's TPVs are mainly EPDM types. ZEON and DuPont's products are mainly ACM types. Down Corning's TPSiV is silicon rubber-based.

Chinese Thermoplastic Polyurethane Market

Thermoplastic polyurethane (TPU) is the first commercialized TPE. It usually consists of rigid blocks formed by diphenyl-methane-diisocyanate (MDI) or toluene diisocyanate (TDI) reacting with chain extenders and soft blocks formed by MDI or TDI reacting with high molecular polyols.

TPU has the advantages of high tensile strength, good toughness, abrasion resistance and oil resistance. Major applications include shoe materials, automobiles, tires, oil-resistant hoses, medical products and waterproof membranes.

TPU can be processed by injection molding, extrusion and coating. Estimates and forecasts of the TPU market by processing method through 2019 are provided in the following table.

TABLE 170

CHINESE THERMOPLASTIC POLYURETHANE MARKET BY PROCESSING METHOD, THROUGH 2019
(THOUSAND METRIC TONS)

Processing Method	2013	2014	2019	CAGR% 2014–2019
Injection molding	134.7	147.6	231.7	9.4
Extrusion	45.4	48.8	74.5	8.8
Adhesive	33.5	36.5	56.3	9.1
Coating	9.5	10.2	15.5	8.7
Total	223.0	243.1	378.0	9.2

Source: BCC Research

Estimates and forecasts of the TPU market by application through 2019 are provided in the following table.

TABLE 171

CHINESE THERMOPLASTIC POLYURETHANE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Footwear	75.8	82.6	122.9	8.3
Engineering	49.1	53.5	83.2	9.2
Adhesives	33.5	36.5	56.3	9.1
Automotive	22.3	24.3	40.8	10.9
Others	42.4	46.2	74.8	10.1
Total	223.1	243.1	378.0	9.2

Source: BCC Research

Thermoplastic Polyurethane Producers

Taiwan, Europe and the U.S. are main TPU manufacturing regions. China’s TPU capacity has quickly expanded in recent years.

There are more than 20 TPU manufacturers in Taiwan, with an annual capacity of more than 100,000 metric tons. Taiwanese TPU producers include Sunko Ink Co. Ltd., Coating Chemical Industry Co. Ltd. and Evermore Chemical Industry Co. Ltd.

China has production facilities of TPU in Yantai, Baoding, Jinjiang and Nantong. China consumes nearly 40% of the global TPU output. It also produces more than 40% of the global TPU capacity.

Major TPU producers and developers include Bayer, Huntsman, Lubrizol, BASF, Wanhua and Sunko.

Important acquisitions in the TPU industry in recent years include:

- Noven was purchased by Lubrizol. Noven has a $1 billion TPU market.
- The Taiwan-based Ure-Tech Co. was purchased by Bayer. Ure-Tech has a big share in the Mainland China market.

China's TPU capacity holds 40% of the global share, and it is still growing at a fast pace. It is estimated that Chinese capacity will soon account for half of the world's TPU capacity.

Leading Chinese companies and their capacities in 2013 are detailed in the following table.

TABLE 172

LEADING CHINESE THERMOPLASTIC POLYURETHANE MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity
Zhejiang Huafeng	35
Wanhua	34
Bayer Shenzhen	30
BASF China	29
Lubrizol Shanghai	20
Dongguan Hongde	20
Baoding Bangtai	25
Shanghai Lianjing	10
Suzhou Wositing	10
Other Chinese companies	147
Total	360

Source: BCC Research

Some of the expansion plans of China-based TPU facilities in the next two years include:

- Huntsmand Shanghai (www.huntsman.com) launched a new plant with an annual capacity of 21,000 metric tons of TPU in early 2014.
- Polyol is adding a capacity of 7,500 metric tons per year, which will be put into production in 2015.
- Baoding Bangtai plans to increase its total TPU capacity to 22,500 metric tons per year.
- Xuchuan Chemical plans to set up a TPU facility with an annual capacity of 20,000 metric tons.

It is therefore estimated that China's total TPU capacity will reach 431,000 metric tons per year by 2016.

Thermoplastic Polyurethane Technologies

Modifying TPI or MDI can improve the performances of TPU. For example, 1,4-phenylene diisocyanate (PPDI) is a solidification agent for high-performance TPU. PPDI-TPU has much higher tensile strength and tearing strength compared to conventional TPU. When the temperature is greater than 120°C, the tensile and tearing strengths of PPDI-TPU can remain at approximately nine MPa and 10 $kN*m^{-1}$, respectively, which have almost no difference from when it is at 50°C, several times higher than conventional TPUs whose performance drops significantly at high temperature. This means PPDI-TPU has much better thermal resistance than common TPUs.

Other important TPU R&D includes the development of new types of dimethyl-biphenyl diisocyanate (TOPI) TPU and 1,5-naphthalene diisocyanate (NDI) TPU.

Chinese Thermoplastic Polyester Elastomer Market

Thermoplastic polyester elastomer (TPEE) is a blend of polyester and polyether. At low strain condition, TPEE has higher modulus than most other TPEs. TPEE has much higher compression modulus and tensile modulus than TPU. In addition, TPEE has excellent low-temperature notched impact strength, abrasion resistance and fatigue resistance.

These advantages allow TPEE to be used in environments that require high performance. Major applications include automotive components, industrial products (e.g., hoses, belts) and appliances.

Automotive is the most important TPEE application sector. Estimates and forecasts of the Chinese TPEE market by application through 2019 are provided in the following table.

TABLE 173

CHINESE THERMOPLASTIC POLYESTER ELASTOMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	17.2	18.8	29.5	9.4
Industry (e.g., hoses, belts)	8.9	9.7	15.1	9.3
Appliances	4.6	5.0	7.8	9.3
Others	2.3	2.5	3.6	7.6
Total	33.0	36.0	56.0	9.2

Source: BCC Research

Thermoplastic Polyester Elastomer Suppliers.

Major global TPEE producers and developers include DuPont, Lanxess (formerly DSM Elastomers) and LG. DuPont's product is marketed under the brand name Hytrel. LG's TPEE brand is Keyflex.

Other Thermoplastic Elastomers

Other TPEs include TPA, TPVC and MPR.

Polyamide Thermoplastic Elastomer

Polyamide thermoplastic elastomer (TPA) is blend of polyamide and polyester or polyether. Like polyamide, TPA has high tensile and toughness and good abrasion resistance. It is also resistant to oil and heat, and it has very good processability.

The polyamide TPA segment could be nylon 6, nylon 66 or nylon 12.

Nylon-12 TPA is regarded as a high-end TPA. It could be the most common commercialized TPA due to its excellent corrosion resistance and processability, and it is usually used to replace fluoroelastomers (FKM and FEPM) and silicone rubber.

The low-end TPAs such as nylon-6 TPA also have very good market potential. Nylon-6 TPA can be made at a lower cost than TPU while having similar processability as TPEE.

Major TPA applications include wire and cable sheath in automobiles or appliances, footwear, medical tubes and resins modification.

Polyvinyl Chloride-Based Thermoplastic Elastomer

Polyvinyl chloride-based thermoplastic elastomer (TPVC) can be designed to have different hardness by adjusting the use of plasticizers. It has good coloring performance, and it is resistant to weathering, ozone, chemicals, scratching and heat. These advantages make it to good choice for sealing materials, wire and cable sheath for automobiles, appliances, industrial products, architecture, sports products, and medical products such as blood transfusion bags and tubes.

Melt Processable Rubber

Melt processable rubber (MPR) has excellent elasticity, and it is resistant to heat, oil and many chemicals. Its main performance does not change significantly even after repeated processing. Its resistance to flame, weathering and ozone is better than most other TPEs.

Major MPR applications include sealing strips, sealing pads, wire and cable sheath, footwear and gloves.

Chapter 9

OTHER REGIONS ELASTOMER MARKET

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 9
OTHER REGIONS ELASTOMER MARKET

The chapter describes the elastomer market in other regions, which include South America, Africa and Oceania. Like other chapters, it breaks the market down into segments at different levels:

- The elastomer market is broken down into two major segments: thermoplastic elastomers (TPEs) and thermoset elastomers (TSEs). Thermoset elastomers are elastomers that irreversibly cure. Thermoplastic elastomers are pliable or moldable above specific temperatures and return to solid state upon cooling.

- The TSE segment is further divided to three sub-segments: natural rubber (NR), synthetic rubbers (SRs) and recycled rubbers (RRs). Recycled rubber is also known as reclaimed rubber.

- The Synthetic Rubbers sub-segment is further broken down into eight sections: IR, BR, SBR, NBR, CR, IIR, EPR and Others. The EPR section includes EPM and EPDM. The Others section is mostly comprised of saturated rubbers that have relatively small volumes, including ethylene acrylate (AEM), fluoroelastomers (FKM), epichlorohydrin rubber (ECO), silicone rubber (e.g., fluorosilicone [FMVQ]), acrylic elastomer (ACM) and chlorosulfonated polyethylene (CSM).

- The TPE segment is further divided to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs that have relatively small volumes of consumption, including TPA, TPVC and MPR.

- A TSE or TPE product may be further broken down into sections by sub-products.

Most segments, sub-segments and sections will be further divided or described by regions and applications. Capacities, technologies, industry trends and leading players will be also discussed.

The following table presents the estimates and forecasts of two major markets: TSEs and TPEs.

TABLE 174

OTHER REGIONS ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
Thermoset	1,841.2	1,889.4	2,202.3	3.1
Thermoplastic	177.7	187.7	260.5	6.8
Total	2,018.9	2,077.1	2,462.8	3.5

Source: BCC Research

TSE consumption will have stable growth in the next few years, but TPEs will experience stronger growth.

THERMOSET ELASTOMERS

Thermoset elastomers, also known as rubbers, include natural rubber (NR) and synthetic rubbers (SRs). In some countries, the term *synthetic rubbers* also includes some types of thermoplastic elastomers, such as thermoplastic styrene elastomers (TPSs), also known as styrenic block copolymers (SBCs). This report excludes all thermoplastic elastomers from the Synthetic Rubber and Rubbers categories. As a result, SBCs are put in the Thermoplastic Elastomer category.

Recycled rubber (RR), also known as reclaimed rubber, maintains a significant market share in some countries, such as China. This report breaks the thermoset elastomer market down into three segments: natural rubbers, synthetic rubbers and recycled rubbers.

Estimates and forecasts of the rubber market in other regions through 2019 are provided in the following table.

TABLE 175

OTHER REGIONS THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs	1,101.2	1,138.0	1,343.4	3.4
NR	690.0	700.0	800.0	2.7
RRs	50.0	51.4	58.9	2.8
Total	1,841.2	1,889.4	2,202.3	3.1

Source: BCC Research

Recycled rubbers include recycled natural rubber (RNR) and recycled synthetic rubber (RSR). The estimates and forecasts of recycled rubber market in these regions by product is shown in the following table.

TABLE 176

OTHER REGIONS RECYCLED RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs	40.0	41.1	47.2	2.8
NR	10.0	10.3	11.7	2.6
Total	50.0	51.4	58.9	2.8

Source: BCC Research

According to experts, 3.0 metric tons of recycled natural rubber can be used to replace one metric ton of natural rubber, and 1.5 to 2.0 metric tons of recycled synthetic rubber can replace one metric ton of synthetic rubber. Therefore, this report assumes 3.0 metric tons of recycled natural rubbers equals one metric ton of natural rubber, and 1.75 metric tons of recycled synthetic rubbers equals one metric ton of synthetic rubber. The numbers of recycled rubber volume in the previous table have been converted into *metric ton natural rubber equivalent* and *metric ton recycled rubber equivalent*.

If RNR is put into the NR segment and RSR is put into the SR segment, the estimates and forecasts of the thermoset elastomer market in other regions will resemble those shown in the following table.

TABLE 177

OTHER REGIONS THERMOSET ELASTOMER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SRs*	1,141.2	117.9	1,390.6	3.4
NR*	700.0	710.3	811.7	2.7
Total	1,841.2	1,889.3	2,202.3	3.1

*NR and SRs here include recycled rubber volume.

Source: BCC Research

Synthetic rubbers include IR, BR, SBR, NBR, CR, IIR, EPM/EPDM, ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

NATURAL RUBBERS

Natural Rubbers and Compounded Rubbers

In this report, the Natural Rubber segment includes natural rubber and compounded rubbers.

Natural rubber consists of polymers of organic compound isoprene with impurities of other organic compounds plus water. Commercial natural rubbers include standard rubber and ribbed smoked sheet (RSS).

Compounded rubbers usually consist of 95% to 99.5% natural rubbers, which are mostly polyisoprene, with additional chemicals such as stearic acid, styrene butadiene rubber, synthetic polyisoprene (IR), butadiene rubber (BR), carbon black, peptizers and nihil album. In this report, the volume of compounded rubber does not include additional chemicals.

Nearly 90% of the world's natural rubbers are produced in Southeast Asian countries such as Thailand, Malaysia, Indonesia and Vietnam. In 2013, the global natural rubber acreage was nearly 13.1 million hectares, with a total output of 12.4 million metric tons, up 3.8% from the previous year. Asia produced 11.4 million metric tons, taking 92% of the global production.

Other Regions Natural Rubber Consumption by Country

China, Europe, India, the U.S. and Japan are the main natural rubber-consuming countries. Major natural rubber producers such as Indonesia, Thailand, Malaysia and Vietnam are also experiencing growing natural rubber consumption, as the global industrial chain has moved some of the capacity of rubber products to these regions.

Estimates of natural rubber consumption and their percentages in these regions in 2013 are provided in the following table.

TABLE 178

OTHER REGIONS NATURAL RUBBER CONSUMPTION, 2013
(THOUSAND METRIC TONS/%)

Country	Consumption	Percent
Brazil	410	59.4
Argentina	40	5.8
Venezuela	20	2.9
Other South American countries	80	11.6

South Africa	60	8.7
Nigeria	20	2.9
Other Africa countries	40	5.8
Australia and New Zealand	20	2.9
Total	690	100.0

Source: BCC Research

Brazil is not only an important natural rubber-producing country in South America, but it is an important consumer. South Africa contributed to approximately 60% of African natural rubber consumption.

Other Regions Natural Rubber Production

Estimates of natural rubber production in other regions in 2013 are shown in the following table.

TABLE 179

OTHER REGIONS NATURAL RUBBER PRODUCTION, 2013
(THOUSAND METRIC TONS)

Region	Production	Percent
Africa	550	70.5
South America	220	28.2
Papua New Guinea	10	1.3
World total	780	100.0

Source: BCC Research

Africa’s production of natural rubbers grew from 0.15 million metric tons in 1961 to 0.55 million metric tons in 2013. It is the second-largest natural rubber-producing continent after Asia.

South American countries such as Brazil have been able to maintain stable natural rubber production.

In Oceania, Papua New Guinea’s production of natural rubbers was expected to be nearly 9,000 metric tons in 2013.

SYNTHETIC RUBBERS

Synthetic rubbers are thermoset elastomers mainly produced from petroleum byproducts. In this report, this segment is further broken down into eight sections: IR, BR, SBR, NBR,

CR, IIR, ERP and Others. The ERP section includes EPM and EPDM. The Others section is mostly comprised of saturated rubbers that have relatively small volumes, including ECO, AEM, FKM, ECO, silicone rubber (SIR), ACM and CSM.

Estimates and forecasts of the synthetic rubbers market in other regions through 2019 are provided in the following table.

TABLE 180

OTHER REGIONS SYNTHETIC RUBBER MARKET BY PRODUCT, THROUGH 2019 (THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
SBR	540.0	554.4	634.3	2.7
BR	208.0	215.5	257.2	3.6
EPR	98.0	104.0	139.8	6.1
IIR	68.0	70.4	83.6	3.5
NBR	38.0	39.6	48.4	4.1
IR	22.0	22.8	27.0	3.4
CR	13.0	13.1	13.4	0.5
Others	114.2	118.2	139.7	3.4
Total	1,101.2	1,138.0	1,343.4	3.4

Source: BCC Research

SBR will remain the largest segment in the following five years, but its market share will decline.

Other Regions Styrene Butadiene Rubber Market

world’s largest synthetic rubber family. Major types include emulsion-polymerized styrene butadiene rubber (ESBR) and solution polymerized styrene butadiene rubber (SSBR).

Estimates and forecasts of SBR consumption in other regions by product through 2019 are provided in the following table.

TABLE 181

OTHER REGIONS STYRENE BUTADIENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
ESBR	485.0	495.7	552.6	2.2
SSBR	55.0	58.7	81.6	6.8
Total	540.0	554.4	634.3	2.7

Source: BCC Research

ESBR will continue to take most of the market share, but SSBR will experience much faster growth.

In these regions, oil-extended ESBR accounts for nearly one-third of total ESBR consumption. Oil-extended ESBR has lower heat generation, better processability and better flex resistance compared to non-oil extended versions. When used for tread, oil-extended ESBR has better traction performance and abrasion resistance. Oil-extended ESBR is mostly used for making tire treads and side walls.

Major SBR applications include tires, automotive components, conveyer belts, hoses, tapes, footwear, medical products and modifiers.

Most SBRs are used for tire manufacturing. Estimates and forecasts of SBR consumption by application through 2019 are provided in the following table.

TABLE 182

OTHER REGIONS STYRENE BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	302.4	310.5	355.2	2.7
Automotive	7.9	8.5	11.4	6.0
Others	229.7	235.4	267.7	2.6
Total	540.0	554.4	634.3	2.7

Source: BCC Research

In tire applications, SBR is mostly used for treads, side walls and carcasses. SBR is widely used for tires in passenger cars, tractors and motorcycles. It is rarely used for heavy-duty tires.

In automotive applications, SBR is used to make hoses, V-belts, synchronous belts, O rings, sealing strips and shock-reducing rubber.

Other applications include footwear, conveyer belts, hoses, tapes, medical products and modifiers.

Styrene Butadiene Rubber Producers

- *Emulsion-Polymerized Styrene Butadiene Rubber Producers*

Leading global ESBR manufacturers include China National Petroleum Corporation (CNPC), Kumho Tires and Sinopec. These three companies hold nearly one-third of the world's capacity.

- *Solution Polymerized Styrene Butadiene Rubber Producers*

Leading SSBR manufacturers include Styron, Firestone, Michelin, Japan Synthetic Rubber and Goodyear. These four companies produce more than 40% of the world's capacity. Firestone is now part of Bridgestone.

Capacities of leading SSBR manufacturers are provided in the following table.

TABLE 183

LEADING OTHER REGIONS SOLUTION POLYMERIZED STYRENE BUTADIENE RUBBER MANUFACTURERS BY CAPACITY, 2013 (THOUSAND METRIC TONS)

Company	Capacity	Products
Petroflex, Brazil	20	SSBR/BR/SBS
Karbochem, South Africa	20	SSBR/BR
World total	40	

Source: BCC Research

Styrene Butadiene Rubber Technologies

Leading players in SBR R&D include Goodyear, Bridgestone, Japan Synthetic Rubber Co. Inc., BASF, Dow Chemical and ZEON. They license their manufacturing technologies and patents to manufacturers in Asia, South America and Africa.

Technological trends of emulsion-polymerized styrene butadiene rubber include:

- Higher monomer conversion percentage.

- New functional monomers for improving rubber performance.
- New types of emulsifiers and conditioning agents.
- Environmentally friendly termination agents.
- Powder manufacturing methods.

For SSBR production, most of the manufacturers use manufacturing technologies based on the Phillips' batch polymerization method. Others use continuous polymerization process based on the Firestone method. Firestone is now part of Bridgestone.

Technological SSBR innovations mainly focus on microstructure control. An example is developing a functional SSBR with high ethylene content and moderate and controllable styrene content by using new types of multifunctional initiators, couplers and conditioning agents.

Other Regions Butadiene Rubber Market

Butadiene rubber is an elastomer polymerized by 1,3-butadiene monomers, which is a conjugated diene with the formula C_4H_6.

BR is mostly used for making tires. It is also used as an impact-resistance modifier in making high-impact polystyrene (HIPS) and acrylonitrile butadiene styrene (ABS).

Estimates and forecasts of BR consumption in other regions by major application through 2019 are provided in the following table.

TABLE 184

OTHER REGIONS BUTADIENE RUBBER MARKET BY APPLICATION, THROUGH 2019 (THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	137.3	142.2	170.2	3.7
HIPS	21.6	22.4	26.6	3.5
ABS	10.4	10.8	12.3	2.6
Others	38.7	40.1	48.1	3.7
Total	208.0	215.5	257.2	3.6

Source: BCC Research

In tire applications, BR is mostly used for making treads and side walls. Nd-BR is a promising type due to its advantages such as high tensile strength, low heat generation, low hysteresis loss, excellent flex resistance and wet traction, and low rolling resistance.

As an impact-resistance modifier for HIPS, the additive BR equals to 5% to 8% of HIPS in terms of volume.

As a modifier for making ABS, 1one kilogram of ABS is added with 0.1 kilograms to 0.2 kilograms BR.

BR is also used for making hoses, belts, sports products, automotive parts and other products.

Butadiene Rubber Producers

Major BR producers include Sinopec, Lanxess, Kumho, Michelin, Goodyear, UBE, Eni, CNPC and Sibur.

Butadiene Rubber Technologies

The leading global players in BR R&D include UBE, Goodyear, Bridgestone, Japan Synthetic Rubber and Lanxess.

- *Ti-BR:* The only large Ti-BR producer is the Russia-based Sibur. This technology could be phased out in the future.
- *Co-BR:* Technological innovations focus on making syndiotactic 1,2 polybutadiene with different crystallinity and melting temperatures.
- *Ni-BR:* The focus is on high cis-hyperbranched BR.
- *Li-BR:* The focus is developing low-cis BR (LCBR) with different ethylene content.
- *Nd-BR:* The focuses include advanced initiating systems and related polymerization processes, as well as chain-end modification technologies.
- *Others:* Other important trends include making high ethylene content BR by using Mo or Fe initiating systems.

Other Regions Nitrile Rubber Market

Nitrile rubber, also known as acrylonitrile butadiene rubber, Buna-N and Perbunan, is a copolymer of acrylonitrile (ACN) and butadiene. Major types include hydrogenated nitrile rubbers (HNBR), powder nitrile rubbers (PNBR) and carboxylated nitrile rubbers (XNBR).

Estimates and forecasts of NBR consumption in other regions by product through 2019 are provided in the following table.

TABLE 185

OTHER REGIONS NITRILE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
HNBR	3.2	3.5	5.0	7.4
PNBR	3.0	3.2	4.4	6.6
Others	31.8	32.9	39.0	3.5
Total	38.0	39.6	48.4	4.1

Source: BCC Research

Major NBR products include hoses, belts, wire and cable, O rings, adhesives, sealants, footwear and molded products. Many of these products are used in automobiles.

More than 60% of HNBR in other regions is used for automotive purposes. Estimates and forecasts of HNBR consumption and automotive applications in these regions through 2019 are provided in the following table.

TABLE 186

OTHER REGIONS HYDROGENATED NITRILE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	1.9	2.1	3.0	7.4
Others	1.3	1.4	2.0	7.4
Total	3.2	3.5	5.0	7.4

Source: BCC Research

In these regions, an automobile usually consumes 0.3 kilograms to 0.6 kilograms of HNBR.

Nitrile Rubber Producers

The leading global players of NBR production and R&D include Lanxess, ZEON, Bayer, Sinopec, Sibur, JSR and Polimeri. ZEON NBR’s trade name is Nipol, and Lanxess’ NBR is marketed under the trade name Krynac.

Nitrile Rubber Technologies

The leading global NBR R&D companies include Lanxess, Bayer, ZEON and Eni.

Major NBR R&D advances include polymerization formulas, polymerization methods, automatic control technologies and new grades of products.

Focus is placed on high-efficiency and environmentally friendly polymerization formulas.

New products are specialized and differentiated NBR for different applications. They include chain-end NBR, carboxylated nitrile rubber (XNBR), fast-vulcanized NBR, hydrogenate NBR (HNBR), third monomer-copolymerized NBR and powder NBR.

Other Regions Isobutylene Isoprene Rubber Market

Isobutylene isoprene rubber (IIR), also known as butyl rubber, is a copolymer of isobutylene and isoprene. IIR has excellent impermeability and good flex properties. Its air permeability is only one-seventh of natural rubber and one-fifth of styrene butadiene rubber. Its steam permeability is only 1/200 of natural rubber and 1/140 of styrene butadiene rubber.

Most of the commercialized IIR are halogenated. The halogenated IIR (HIIR) include chloro isobutylene isoprene rubber (CIIR) and bromo isobutylene isoprene rubber (BIIR).

Estimates and forecasts of IIR and HIIR consumption in other regions through 2019 are provided in the following table.

TABLE 187

OTHER REGIONS ISOBUTYLENE ISOPRENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
HIIR	44.9	46.5	56.8	4.1
Others	23.1	23.9	26.8	2.2
Total	68.0	70.4	83.6	3.5

Source: BCC Research

Major IIR products include tires, electric insulation materials, medical bottle plugs, gas masks and sealing materials.

Nearly two-thirds of HIIR in these regions are used for tire purposes. Estimates and forecasts of HIIR consumption and automotive applications in these regions through 2019 are provided in the following table.

TABLE 188

OTHER REGIONS HALOGENATED ISOBUTYLENE ISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	32.0	33.4	41.4	4.4
Others	12.9	13.1	15.4	3.3
Total	44.9	46.5	56.8	4.1

Source: BCC Research

In tire applications, IIR is mostly used for making inner liners and inner tubes.

Isobutylene Isoprene Rubber Producers

Exxon Mobil and Lanxess are the world's two largest IIR producers. Exxon Mobil produces nearly half of the world's capacity with its subsidiaries and joint ventures.

Isobutylene Isoprene Rubber Technologies

The leading global players for IIR R&D include Exxon Mobil, Lanxess and Bayer.

IIR R&D mainly focuses on advanced initiating systems, high polymerization temperature, improved reactors and new products development.

Other Regions Ethylene Propylene Rubber Market

Ethylene propylene rubber includes ethylene propylene monomer (EPM) and ethylene propylene diene monomer (EPDM). EPR is resistant to heat, oxidation, ozone, steam, water, chemicals and weathering. It can be used at temperatures from -55°C to 150°C. At 120°C EPR can also be used for long periods. Above 120°C, the aging of EPR could be accelerated, and the service life will be shortened. It can be used under even worse conditions by oxide crosslinking.

EPR has excellent electrical insulation properties. It has low density (0.87), and it can be filled with oil and other materials to lower costs. For high Mooney viscosity EPR, filling with other materials does not reduce EPR's mechanical properties to a significant degree.

The disadvantages of EPR include poor oil resistance and long cure time, which is three- to four-times longer than most of other synthetic rubbers. In addition, EPR has low adhesiveness to itself and other materials, which makes it difficult to process.

Estimates and forecasts of EPR consumption in other regions by product through 2019 are provided in the following table.

TABLE 189

OTHER REGIONS ETHYLENE PROPYLENE RUBBER MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
EPDM	84.3	89.4	120.5	6.2
EPM	13.7	14.6	19.3	5.7
Total	98.0	104.0	139.8	6.1

Source: BCC Research

EPR is used for automotive, blend modification, architecture, wire and cable, and tires. Estimates and forecasts of EPR consumption in other regions by application through 2019 are provided in the following table.

TABLE 190

OTHER REGIONS ETHYLENE PROPYLENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	30.2	32.4	44.1	6.4
Blend modifications	14.7	15.6	21.1	6.2
Architecture	7.8	8.3	11.0	5.8
Wire and cable	3.9	4.2	5.5	5.5
Tires	2.1	2.2	2.9	5.7
Others	39.3	41.3	55.2	6.0
Total	98.0	104.0	139.8	6.1

Source: BCC Research

EPR is the most widely used automotive rubber (except for tire applications). It is used for making sealing strips for automotive doors and windows, ventilation pipes for air conditioners, seal components and hoses.

In blend-modification applications, EPR is used to improve other rubbers or polymers' resistance to heat, oxidation, ozone, steam and low temperatures.

In architectural applications, EPR is used for waterproof rolls, sealing strips and sports tracks.

Ethylene Propylene Rubber Producers

Major EPR producers include Exxon Mobil, Mistsui Chemicals, Lanxess, Dow Chemical, Crompton, DuPont, Herdillia, Kumho, Mitsui Chemicals, Versalis (former Polimeri Europa) and Sumitomo Chemical.

Lanxess Brazil, formerly DSM Brazil, is the only major EPR producer in the other regions. It produces EDPM by solution method, with a capacity of 42,000 metric tons per year.

Ethylene Propylene Rubber Technology Research and Development

The leading global players for EPR R&D include Exxon Mobil, Lanxess, Mistsui Chemicals and Bayer. The solution polymerization method dominates global EPR production.

EPR R&D mainly focuses on advanced initiating systems and polarization modification.

- The initiating systems have moved from V and Ti systems of the Ziegler-Natta series to metallocene and low-valence homogeneous systems.
- Polarization modification is usually used to improve EPR's compatibility to other rubbers and materials. Examples include chloration, sulfonation, and blending modifications with organic silicon and nylon.

Other Regions Polyisoprene Rubber Markets

Polyisoprene rubber (IR) is a synthetic rubber with similar properties to natural rubber, so in some countries it was called *synthetic natural rubber*. It has better water resistance and electrical insulation than natural rubber. The strength, adhesiveness and processability of raw rubber and the tearing strength and fatigue resistance of cured rubber are usually slightly lower than that of natural rubber.

Estimates and forecasts of IR consumption in other regions by application through 2019 are provided in the following table.

TABLE 191

OTHER REGIONS POLYISOPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Tires	17.6	18.2	21.7	3.6
Machinery	1.4	1.5	1.8	3.7

Footwear	1.1	1.1	1.3	3.4
Adhesives and sealants	0.9	0.9	1.1	4.1
Others	1.0	1.1	1.2	3.7
Total	22.0	22.8	27.0	3.4

Source: BCC Research

For tire applications, IR is used in treads, side walls, carcasses, inner liners, belt plies and tire shoulders.

Synthetic Polyisoprene Producers

Major global IR producers include NKNH, Sibur (Togliattikauchuk), Goodyear and Sinopec.

Karbochem, located in Newcastle, South Africa, is the only IR producer in these regions. It has an annual capacity of 3,000 metric tons.

Synthetic Polyisoprene Technologies

The global leading players for IR R&D include Goodyear, Bayer, Japan Synthetic Rubber and Kuraray.

Technological trends of IR include:

- *Li-IR:* Cis contents could be increased by introducing active components into lithium initiator. For example, cis content is increased to more than 98% by using n-BuLi with 1, 3-dibromobenzene and triphenylamine
- *Ti-IR:* The most popular initiator could be Ti-based initiators. An example is $TiCl_4$-AIR_3 initiator, which could be added with synergistic-effect third component for improving system activity. Chinese companies use Ti-based initiators to produce Trans-1, 4 polyisoprene (TPI), which has been successfully used for replacing natural rubbers in heavy-duty tires.
- *Nd-IR:* Many companies engage in the innovation and optimization of Nd-based initiating system and polymerization process.

Other Regions Chloroprene Rubber Markets

Chloroprene rubber, also known as polychloroprene or Neoprene, the trade name given by DuPont, is a synthetic rubber produced by polymerization of chloroprene. It has good chemical stability and maintains flexibility over a wide temperature range. CR has good mechanical properties, and it is resistant to oil, heat, flame, sunlight, ozone, acid, alkali and chemicals.

The disadvantages of CR include relatively bad low-temperature resistance and poor electrical insulation. In addition, CR has low storage stability. The so-called *bin cure* occurs in storage of raw CR rubber, which increases Mooney viscosity and makes the rubber harder.

Major CR applications include adhesives for footwear and architecture, industrial products (e.g., hoses and belts, sealing strips and pads, white-wall tires, cycle tires), and wire and cable.

Estimates and forecasts of the CR market in other regions by application are provided in the following table.

TABLE 192

OTHER REGIONS CHLOROPRENE RUBBER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Industrial products	7.5	7.6	7.7	0.3
Adhesives	3.8	3.8	3.9	0.5
Wire and cable	1.7	1.7	1.8	1.1
Total	13.0	13.1	13.4	0.5

Source: BCC Research

Chloroprene Rubber Producers

Major global CR producers include Denka, DuPont and Lanxess. Global CR capacity reached its historical height of 800,000 metric tons in the 1980s. From the early 1990s and mid-2000s, however, CR was gradually replaced by EPR and other rubbers, especially in automotive applications, and capacity dropped significantly. After 2005, CR demands from Asia, (especially China) re-grew due to the booming automobile and real estate markets there. It’s estimated that global CR capacity will continue slow growth in the following five years.

These regions do not have CR manufacturers. The CR consumed in these regions is imported from other regions.

Chloroprene Rubber Technologies

The leading global players for CR R&D include Denka, DuPont, Bayer and Lanxess.

The raw materials of CR are toxic and cause great damage to the environment, so CR has higher environmental costs than most other synthetic rubbers. In addition, the manufacturing process is relatively long and costly, so CR has been gradually replaced by other rubbers.

CR is still widely used in adhesives. R&D for CR mainly currently focuses on graft modification of solvent-type CR. Graft modification improves the bonding ability between CR and some types of advanced materials. Powder technology is another direction for CR innovations.

Markets for Other Synthetic Rubbers

Other important synthetic rubbers include ECO, AEM, FKM, silicone rubber (SIR) and ACM. In this report, silicone rubber includes fluorosilicone rubber (FVMQ).

In these regions, nearly 10% of these rubbers are used for automotive purposes (except for tire applications). Estimates and forecasts of some of these rubbers used for automotive purposes are provided in the following table.

TABLE 193

OTHER REGIONS SYNTHETIC RUBBER AUTOMOTIVE APPLICATION MARKET BY PRODUCT, THROUGH 2019
(THOUSAND METRIC TONS)

Product	2013	2014	2019	CAGR% 2014–2019
FKM	4.7	5.1	7.2	7.1
SIR	3.1	3.4	5.0	8.0
ECO	2.7	2.9	4.4	8.7
ACM	1.5	1.7	2.7	9.7
AEM	1.1	1.2	2.2	12.9
Total	13.1	14.3	21.5	8.5

Source: BCC Research

Fluorocarbon Rubber

Fluorocarbon (FKM) is resistant to high temperatures, ozone, oxygen, oil and many other chemicals. Under dynamic conditions, the lowest service temperature is approximately 15°C (5°F). Gas permeability is very low and similar to that of butyl rubber. Special FKM compounds exhibit improved resistance to acids and fuels.

Globally, nearly 60% of FKM is used for the automotive industry. Major applications include fuel hoses, gas pipes, fuel pump and jet device seals, valve stem seals, dynamic seals, piston seals, crankshaft oil seals, universal joint gaskets, O rings and air conditioning compressor seals. An automobile could use 0.2 kilograms to 1.6 kilograms of FKM.

Epichlorohydrin Rubber

Epichlorohydrin (ECO) is copolymer or homopolymer with similar properties to nitrile rubber, but with better oil and heat resistance. It has a low gas permeability and better low temperature flexibility than NBR. It is resistant to acids, alkalis and ozone. Disadvantages of ECO include poor compression set and corrosive effect on metals.

ECO was first developed by two U.S. companies–Goodrich and Hercules—in the 1960s. Goodrich produced ECO under the trade name Hydrin, and Hercules produced ECO under the trade name Herclor. ZEON entered the ECO industry in 1970s under an agreement with Hercules and another Japanese company. Hydrin currently belongs to ZEON.

ZEON's Hydrin polymers are used for fuel oil-resistant applications for automobile gaskets, hoses and diaphragms, as well as for printer rolls and anti-static applications.

Fluorosilicone Rubber

Fluorosilicone rubber (FVMQ) contains trifluoropropyl groups next to the methyl groups. The mechanical and physical properties are similar to VMQ. FVMQ offers improved fuel and mineral oil resistance, but poor hot air resistance when compared with silicone rubber (VMQ).

THERMOPLASTIC ELASTOMERS

TPEs include SBC (also known as TPS), TPO, TPV, TPEE, TPU, TPA, TPVC and MPR.

ADVANTAGES

In many applications, TPEs are advanced and better replacements than TSEs.

- TPEs have simpler manufacturing methods for making end products. For example, making automobile rubber seal strips from ethylene propylene diene monomer (EPDM) requires three steps: mixed compounding, molding and high-temperature vulcanization. Making the product from TPE only requires a direct molding step. Simpler manufacturing methods largely increase production efficiency.

- TPE saves energy. Processing $1,000 worth of synthetic rubber usually consumes more than one metric ton of standard coal equivalent. According to an automotive manufacturer, the three steps for making one kilogram of automobile rubber seal strips of EPDM could consume 2.2 kilowatts to 2.3 kilowatts. The single molding step for making automobile rubber seal strips of TPE usually consumes no more than 0.6 kilowatts per kilogram. The TPE route reduces energy consumption by 75%. Likewise, compare to making automobile dustproof cover of chloroprene rubber (CR), TPE route could reduce energy consumption by 70% to 80%.

- TPE is recyclable. There are more than 20 million metric tons of waste rubbers per year globally. TPE is more recyclable than synthetic rubbers. Therefore, synthetic rubber replacement with TPE is environmentally friendly.

THERMOPLASTIC ELASTOMERS PRODUCTS

This report divides the TPE market to six sub-segments: SBC (also known as TPS), TPO, TPV, TPEE, TPU and Others. The Others sub-segment is comprised of TPEs that have relatively small volumes of consumption, including TPA, TPVC and MPR.

Other Regions Styrenic Block Copolymers Market

Styrenic block copolymer (SBC) is the most widely-used thermoplastic elastomer. Major SBC types include SBS, SEBS, SIS and SEPS.

Hydrogenated SBCs, including styrene ethylene butylene styrene (SEBS) and styrene ethylene propylene styrene (SEPS), are relatively new SBC types. They have advantages such as better aging resistance and tensile properties than un-hydrogenated SBCs.

Major applications include adhesives and sealants, asphalt modifiers, polymer modifiers, viscosity index (VI) improvers and footwear.

Estimates and forecasts of the SBC market in other regions by application can be found in the following table.

TABLE 194

OTHER REGIONS STYRENIC BLOCK COPOLYMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Asphalt modifiers	16.8	17.4	21.9	4.7
Adhesives and sealants	14.6	15.1	18.1	3.7
Polymer modifiers	11.2	11.6	13.2	2.6
Footwear	6.7	7.0	7.6	1.7
Viscosity index improvers	0.6	0.6	0.7	3.1
Others	6.2	6.4	7.9	4.3
Total	56.1	58.1	69.4	3.6

Source: BCC Research

Styrenic Block Copolymer Producers

Major global SBC producers include Sinopec, Kraton and LCY Group.

Important facilities and their capacities in other regions are provided in the following table.

TABLE 195

OTHER REGIONS LEADING STYRENIC BLOCK COPOLYMER MARKET MANUFACTURERS BY CAPACITY, 2013
(THOUSAND METRIC TONS)

Company	Capacity	Products
Kraton, Brazil	30.0	SBS/SIS/SEBS
Lanxess, Brazil	10.0	SBS/SEBS
Total	40.0	

Source: BCC Research

Styrenic Block Copolymer Technologies

The leading global players for SBC R&D include Kraton, BASF and Japan Synthetic Rubbers.

SBC R&D currently focuses on:

- New initiating system for lowing costs.
- Diversification and functional SBC performances.
- Low-pressure hydrogenation technologies.
- Radiation SBC curing technologies.
- Energy-saving technologies.
- Reversible addition-fragmentation chain transfer (RAFT) polymerization technology for making SBC with excellent heat resistance and solvent resistance.

Tread rubber, bead filler and inner liner account for 39%, 13% and 8% of the oil consumption of a tire, respectively.

Other Regions Thermoplastic Polyolefin Market

Thermoplastic polyolefin (TPO), also known as polyolefin elastomer (POE), is a blend of polyolefins and rubbers. The rubber contents usually includes EPDM, NBR, IIR or natural rubber. Polyolefins are usually PP or PE. The widely used TPO is blended by EPDM and PP.

Through manufacturing methods, TPO can be divided by reactor-made thermoplastic polyolefin (RTPO) and blended thermoplastic polyolefin (BTPO).

Most of the world’s TPO elastomers are used for automotive purposes, including panels, buffer capsules, tubes, gear covers, sealing materials and interior materials. Other important applications include appliances, machinery, medical, architecture and sports products.

Important TPO brands include Exact by ExxonMobil Chemical and Engage by Dow Chemical.

Estimates and forecasts of the TPO market and automotive applications in other regions through 2019 are provided in the following table.

TABLE 196

OTHER REGIONS THERMOPLASTIC POLYOLEFIN MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	30.8	33.2	53.0	9.8
Others	18.8	20.4	31.8	9.3
Total	49.6	53.6	84.8	9.6

Source: BCC Research

Other Regions Thermoplastic Vulcanizate Market

Thermoplastic vulcanizate (TPV) can be perceived as a vulcanized and upgraded version of TPO. TPV has excellent elasticity and compression deformation resistance. It has environmental and aging resistance similar to EPDM. In addition, it has oil and solvent resistance similar to chloroprene rubber. Therefore, TPV is regarded as the more recyclable and environmentally friendly replacement to rubbers, especially to EPDM in automotive applications.

Most of the world’s TPV elastomers are used for automotive purposes, including sealing strips, tubes and interiors. In developed countries, an automobile could contain four to five kilograms of TPV. In developing countries such as China and India, TPV consumption is usually less than two kilograms per vehicle.

Other important applications include appliances, medical, architecture and sports products.

Estimates and forecasts of the TPV market and automotive applications in other regions through 2019 are provided in the following table.

TABLE 197

OTHER REGIONS THERMOPLASTIC VULCANIZATE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Automotive	12.4	13.4	22.3	10.7
Others	7.6	8.2	13.3	10.2
Total	20.0	21.6	35.6	10.5

Source: BCC Research

Thermoplastic Vulcanizate Producers

Major TPV producers and developers include Teknor Apex (Sarlink), Advanced Elastomer Systems Limited (Santoprene, Vyram, Geolast), Dawn (Dawnprene), SK (Plastomer), ZEON (Zeotherm), DuPont (ETPV) and Down Corning (TPSiV).

AES's TPVs products include EPDM, NBR and NR types. Teknor Apex, Dawn and SK's TPVs are mainly EPDM types. ZEON and DuPont's products are mainly ACM types. Down Corning's TPSiV is silicon rubber-based.

Other Regions Thermoplastic Polyurethane Market

Thermoplastic polyurethane (TPU) is the first commercialized TPE. It usually consists of rigid blocks formed by diphenyl-methane-diisocyanate (MDI) or toluene diisocyanate (TDI) reacting with chain extenders and soft blocks formed by MDI or TDI reacting with high molecular polyols.

TPU has advantages of high tensile strength, good toughness, abrasion resistance and oil resistance. Major applications include shoe materials, automobile components, tires, oil-resistant hoses, medical products and waterproof membranes.

TPU can be processed by injection molding, extrusion and coating.

TABLE 198

OTHER REGIONS THERMOPLASTIC POLYURETHANE MARKET BY PROCESSING METHOD, THROUGH 2019
(THOUSAND METRIC TONS)

Processing Method	2013	2014	2019	CAGR% 2014–2019
Injection molding	6.3	6.5	9.5	7.9
Extrusion	3.9	4.0	5.2	5.4

Adhesive	3.2	3.3	4.2	4.9
Coating	3.1	3.2	4.0	4.6
Total	16.5	17.0	22.9	6.1

Source: BCC Research

Major applications of include shoe materials, automobile components, engineering, tires, oil-resistant hoses, medical products and waterproof membranes.

Estimates and forecasts of the TPU market by application through 2019 are provided in the following table.

TABLE 199

OTHER REGIONS THERMOPLASTIC POLYURETHANE MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Application	2013	2014	2019	CAGR% 2014–2019
Engineering	4.5	4.6	5.8	4.7
Footwear	4.3	4.4	5.6	4.9
Adhesives	2.0	2.1	2.7	5.2
Automotive	1.7	1.8	2.5	6.8
Others	4.0	4.1	6.3	9.0
Total	16.5	17.0	22.9	6.1

Source: BCC Research

Thermoplastic Polyurethane Producers

Taiwan, Europe and the U.S. are main TPU manufacturing regions. China has also quickly expanded its TPU capacity in recent years.

There are more than 20 TPU manufacturers in Taiwan, with an annual capacity of more than 100,000 metric tons. Taiwanese TPU producers include Sunko Ink Co. Ltd., Coating Chemical Industry Co. Ltd. and Evermore Chemical Industry Co. Ltd.

China has TPU production facilities in Yantai, Baoding, Jinjiang and Nantong. The country consumes nearly 40% of the global TPU output. It also maintains more than 40% of global TPU capacity.

Major TPU producers and developers include Bayer, Huntsman, Lubrizol, BASF, Wanhua and Sunko.

Important acquisitions in the TPU industry in recent years include:

- Noven was purchased by Lubrizol. Noven has a $1 billion TPU market.
- The Taiwan-based Ure-Tech Co was purchased by Bayer. Ure-Tech has a large share in the mainland China market.

China's TPU capacity has reached 40% of the global share, and it is still growing at a fast pace. It is expected that Chinese capacity will soon account for half of the world's TPU capacity.

Thermoplastic Polyurethane Technologies

Modifying TPI or MDI can improve the TPU performance. For example, 1,4-phenylene diisocyanate (PPDI) is a solidification agent for high-performance TPU. PPDI-TPU has much higher tensile and tearing strengths compared to conventional TPU. When the temperature is greater than 120°C, the tensile strength and tearing strength of PPDI-TPU can remain at roughly 9 MPa and 10 $kN*m^{-1}$, respectively, which have almost no difference from when it is at 50°C, several times higher than conventional TPUs, whose performance drops significantly at high temperature. This means PPDI-TPU has much better thermal resistance than common TPUs.

Other important R&D of TPUs include developing new types of dimethyl-biphenyl diisocyanate (TOPI) TPU and 1,5-naphthalene diisocyanate (NDI) TPU.

Other Regions Thermoplastic Polyester Elastomer Market

Thermoplastic polyester elastomer (TPEE) is a blend of polyester and polyether. Under low strain conditions, TPEE has higher modulus than most of other TPEs. TPEE has much higher compression modulus and tensile modulus than its main competitors. In addition, TPEE has excellent low-temperature notched impact strength, abrasion resistance and fatigue resistance.

These advantages allow TPEE to be used in environments that require high performance. Major applications include automotive components, industrial products (e.g., hoses, belts) and appliances.

Estimates and forecasts of TPEE market by application in other regions through 2019 are provided in the following table.

TABLE 200

OTHER REGIONS THERMOPLASTIC POLYESTER ELASTOMER MARKET BY APPLICATION, THROUGH 2019
(THOUSAND METRIC TONS)

Applications	2013	2014	2019	CAGR% 2014–2019
Automotive	5.1	5.3	7.1	6.0
Industry (e.g., hoses, belts)	2.5	2.6	3.3	4.9
Appliances	1.3	1.4	1.7	4.0
Others	1.1	1.2	1.5	4.6
Total	10.0	10.5	13.6	5.3

Source: BCC Research

Thermoplastic Polyester Elastomer Suppliers

Major global TPEE producers and developers include DuPont, Lanxess (formerly DSM Elastomers) and LG. DuPont's product is marketed under the brand name Hytrel. LG's TPEE brand is Keyflex.

Other Thermoplastic Elastomers

Other TPEs include TPA, TPVC and MPR.

Polyamide Thermoplastic Elastomer

Polyamide thermoplastic elastomer (TPA) is blend of polyamide and polyester or polyether. Like polyamide, TPA has high tensile and toughness, as well as good abrasion resistance. It is also resistant to oil and heat, and it has very good processability.

The polyamide segment of TPA could be nylon 6, nylon 66 or nylon 12.

Nylon-12 TPA is regarded as a high-end TPA. It could be the most common commercialized TPA due to its excellent corrosion resistance and processability, and it is usually used to replace fluoroelastomers (FKM and FEPM) and silicone rubber.

The low-end TPAs such as nylon-6 TPA also have very good market potential. Nylon-6 TPA can be made at a lower cost than TPU while having similar processability as TPEE.

Major TPA applications include wire and cable sheath in automobiles or appliances, footwear, medical tubes and resin modification.

Polyvinyl Chloride-based Thermoplastic Elastomer

Polyvinyl chloride -based thermoplastic elastomer (TPVC) can be designed to have different hardness by adjusting the uses of plasticizers. It has good coloring performance, and it is resistant to weathering, ozone, chemicals, scratching and heat. These advantages make it a good choice for sealing materials and wire and cable sheath for automobiles, appliances, industrial products, architecture, sports products, and medical products such as blood transfusion bags and tubes.

Melt Processable Rubber

Melt processable rubber (MPR) has excellent elasticity, and it is resistant to heat, oil and many chemicals. Its main performances do not change significantly even after repeated processing. Its resistance to flame, weathering and ozone is better than most other TPEs.

Major MPR applications include sealing strips, sealing pads, wire and cable sheath, footwear and gloves.

Chapter 10

COMPANY PROFILES

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 10
COMPANY PROFILES

This chapter lists only a small number of elastomer producers. Other important manufacturers and their production capacities are mentioned in the previous chapters

AES

Traston Rd., Corporation Rd.
Newport NP19 4XF
U.K.
Website: www.exxonmobil.com

Advanced Elastomer Systems Limited (AES), an ExxonMobil subsidiary, is one of the leading global suppliers of thermoplastic elastomers (TPEs). Approximately 70 employees and contractors work at the AES manufacturing plant in Newport, Wales, which has the capacity to produce more than 50,000 metric tons of TPEs per annum. TPEs manufactured at the site are marketed under the trademark Santoprene.

AES's TPV products include EPDM, NBR and NR types. Nearly 50% of TPE sales are to the automotive industry, where it is used for car windscreens, under-bonnet applications for interior parts. The versatile product is also used by the construction industry, as well as for consumer goods such as flexible toothbrushes and kitchen utensils.

ASHLAND

50 E. River Center Blvd.
P.O. Box 391
Covington, KY 41012-0391
Tel: 859/815-3333
www.ashland.com

Ashland is one of the largest ESBR producers in North America. In July 2013, Ashland Inc. put its styrene-butadiene rubber business, which includes a 250-employee plant in Port Neches, Texas, up for sale. Ashland acquired the business in August 2011 when it purchased International Specialty Products Inc. (ISP) for approximately $3.2 billion.

CNPC

9, Beida St., Dongzhimen
Dongcheng District, Beijing 10007
China
Tel: 86-10-62094114, Fax: 86-10-62094205
Website: www.cnpc.com.cn

CNPC is one of the two largest Chinese state-owned petrochemical companies and the world's largest EBRS producer. Its three sub-companies have four ESBR facilities, with a total capacity of 500,000 metric tons per annum.

In addition, CNPC has a capacity of 160,000 metric tons of BR per annum. CNPC's subsidiary Dushanzi Petrochemical Co. has a SSBR/SBS plant, with 100,000 metric tons of SSBR and 80,000 metric tons of SBS per annum.

DENKA

Elastomers & Acetylene Black Department
Tel: 81-3-5290-5550, Fax: 81-3-5290-5400
Website: www.denka.co.jp

Denka is one of the world's largest chloroprene rubber (CR) producers, with a capacity of 100,000 metric tons per year. Denka started the production of CR in early 1960s. Denka CR currently includes general grades, DCR series for special applications, adhesives grades and latex grades. Denka supplies CR to more than 50 countries.

Denka ER, a copolymer of ethylen, vinyl acetate and acrylic acid ester, is the company's other elastomer. Denka ER is developed as a special rubber offering superb heat and oil resistance. Typical applications for Denka ER include oil seals, fuel oil components, hoses and gaskets.

Denka also produces highly purified and conductive carbon black, which is used for rubber reinforcements, cables, tires, belts, hoses, flooring, shoes, surface heating elements, black pigment and electronic components.

DUPONT

DuPont Bldg.
1007 Market St.
Wilmington, DE 19898
Tel: 302/774-1000
Website: www.dupont.com

DuPont is the only producer of Neoprene polychloroprene in North America. Invented in 1931, DuPont Neoprene Polychloroprene was originally used as an oil-resistant replacement for natural rubber. It is a versatile synthetic rubber still used for many chemical and weather-resistant applications. It has a capacity of 100,000 metric tons of CR per year.

Other DuPont elastomers include TPU and TPEE (Hytrel).

GOODYEAR TIRE & RUBBER CO

200 Innovation Way
Akron, OH 44316-0001

For general purpose polymers, BR, SSBR, ESBR:
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Goodyear is the world's third-largest tire manufacturer after Bridgestone and Michelin. It is also the world's third-largest SSBR manufacturer after Firestone, which is now part of Bridgestone, and Michelin. Goodyear also produces ESBR, IR, BR and their latex and compounds.

In 2013, Goodyear sold 162.3 million units of tires, down 1.1% from the previous year. The decline was mainly due to decreases in replacement tires in North America (U.S. and Canada), Europe, and the Middle East and Africa (EMEA) region, which put off the growth of synthetic rubbers.

Goodyear's products lines of synthetic rubbers and latex include:

Synthetic rubber:

- Plioflex-General Purpose ESBR (Emulsion copolymer of butadiene and styrene).
- Budene-General Purpose BR (high cis 1,4 polybutadiene).
- Solflex Solution SBR (solution styrene/butadiene copolymer).
- Natsyn IR rubber (synthetic polyisoprene rubber).
- IR monomer (isoprene monomer).

Latex: LPF High-Solid SBR latex (cold polymerized styrene butadiene copolymer).

Food Grade ESBR: Pliogum food-grade SBR (styrene/butadiene copolymer).

JAPAN SYNTHETIC RUBBER CO. LTD.

1-9-2, Higashi-Shinbashi
Minato-ku, Tokyo
Japan
Website: www.jsr.co.jp/jsr_e/index.shtml

Japan Synthetic Rubber Co. Ltd. (JSR) is one of the major Japanese synthetic rubber and TPE manufacturers. Its elastomer product lines include styrene butadiene rubber (SBR), polybutadiene rubber (BR), butyl rubber (IIR), ethylen propylene rubber (EPR), thermoplastic polyolefin (TPO), styrene butadiene thermoplastic elastomer, syndiotactic 1,2-polybutadiene elastomer, styrene isoprene thermoplastic elastomer and special TPE compound products. JSR's elastomer sales, including latex and compounds, reached 203.5 billion yen ($1.97 billion based on the exchange rate on April 1, 2014) in fiscal year 2013–2014 ending on March 31, 2014.

JSR has SSBR production facilities in Japan, Thailand and Hungary (under construction). The Japan-based facility has an annual capacity of 60,000 tons. The Thailand facility started full-scale operation in 2014 with an initial annual capacity of 50,000 tons, which will expand to 100,000 tons by 2017. The Hungary facility is under construction, so JSR have terminated the agreement with the German-based Styrong Europe GmbH for the manufacture of 30,000 tons of SSBR per year. JSR will launch a new plant in Hungary by 2018. Globally, JSR's SSBR production capacity will grow steadily from its current 90,000 tons through 2018. After its Hungary-based facility, which will act as a supply base for Europe and have an annual capacity of 60,000 tons, is put into production in 2018, JSR's SSBR capacity will reach 220,000 metric tons per year.

JSR is a leading researcher for elastomers. It has four R&D centers in Japan. As of March 2014, JSR owned a total of 6,577 patents in Japan and overseas.

KRATON POLYMERS

U.S. Headquarters
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Website: www.kraton.com

Kraton is a specialty polymer producer and a pioneer of styrenic block copolymers (SBCs). The company started to develop and produce SBCs in 1964. Today, Kraton's main elastomer product lines include hydrogenated SBCs (HSBCs), un-hydrogenated SBCs (USBCs), Carflex isoprene rubber (IR) and isoprene rubber latex (IRL, emulsion of IR in water), and compounds. With its joint ventures, Kraton had a 2014 total annual capacity of 435 kilotons of SBCs.

Sales of USBCs accounted 58.3% of the company's total sales of nearly $1.3 billion in 2013. Kraton USBCs are mainly used for adhesives, sealants, coating, paving and roofing, and advanced materials. As of December 31, 2013, Kraton's USBC product portfolio included 101 core commercial grades of products.

Sales of HSBCs accounted for 30.3% of Kraton's total sales in 2013. Major applications include adhesives, sealants, coatings and advanced materials. As of December 31, 2013, Kraton's HSBC product portfolio included 77 core commercial product grades.

Kraton markets its IR and IRL under the Carflex brand name. In 2013, Carflex accounted for 9.0% of Kraton's total sales. Major Carflex IR applications include medical products, adhesives and tackifiers, paints, coatings and photo-resistors. Major Carflex IRL applications include high purity requirements, such as medical products, healthcare, personal care and food contact operations. As of December 31, 2013, the Carflex product portfolio included nine core commercial product grades.

Kraton compounds are mixtures of Kraton polymers and other polymers, resins, oils or fillers, and they cover a wide range of polymers used in consumer and industrial applications. Major applications include soft-touch grips, sporting equipment, automotive components and personal care products. As of December 31, 2013, the Kraton compounds product portfolio included 19 core commercial grades of products. Compounds comprised 2.3% of Kraton's sales revenue in 2013.

In 2013, end uses of adhesives, sealants and coatings accounted for 37.0% of Kraton's total revenues of $1,292 million, covering a wide range of applications from disposable hygiene products to packaging tapes, labels and decals. Advanced materials, paving and roofing, and Carflex, accounted for 26.8%, 27.1%, and 9.0% of Kraton's total 2013 sales, respectively.

Kraton has production facilities in the U.S., Germany, France, Brazil and Japan. It also has R&D centers in the U.S., China, The Netherlands and Japan.

- The Belpre, Ohio-based facility has an annual capacity of 192 kilotons of USBC, HSBC and Carflex products (IR and IRL) . A portion of the HSBC capacity at Belpre is owned by Infineum USA, a joint venture between Shell Chemicals and ExxonMobil that makes products for the lubricant additives business.

- The Wesseling, Germany-based facility has an annual capacity of 96 kilotons of USBC products.

- The Berre, France-based facility has an annual capacity of 87 kilotons of USBC and HSBC products.

- The Paulinia, Brazil-based facility has an annual capacity of 29 kilotons of USBC and a capacity dedicated to producing Carflex IR and IRL.

- The Kashima, Japan-base facility is operated by Kraton JSR Elastomers, a joint venture between Kraton and JSR. It has an annual capacity of 31 kilotons of USBC.

KURARAY

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Japan
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Kuraray is a Japanese manufacturer of liquid isoprene rubber. The company manufactures Kurarity, an acrylic thermoplastic elastomer that is a block copolymer composed of methyl methacrylate (MMA) and butyl acrylate (BA). Kurarity is an acrylic thermoplastic elastomer possessing MMA's transparency and weather resistance, as well as BA's elasticity and adhesive qualities. Kuraray is the first company to successfully achieve the commercial production of such a material.

LANXESS AG

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Lanxess' Performance Butadiene Rubbers (PBR) business unit specializes in the production of versatile polybutadiene, solution styrene-butadiene (SSBR) and neodymium polybutadiene rubbers (Nd-PBR). Lanxess has decided to invest EUR 80 million to convert production of emulsion styrene butadiene rubber (ESBR) used in standard tires to solution styrene butadiene rubber (SSBR) used in high-performance Green Tires at its site in Triunfo (Rio Grande do Sul) in southern Brazil. In October 2013, LANXESS launched two new easy processing neodymium polybutadiene (Nd-PBR) rubber grades to ease the production of fuel-efficient tires, Buna Nd 22 EZ and Buna Nd 24 EZ.

Lanxess is the world's second-largest manufacturer of isobutylene isoprene rubber (IIR), or butyl rubber (BTR), with an annual capacity of 299,000 metric tons.

Lanxess is an important manufacturer of ethylene-propylene monomers (EPMs) and ethylene propylene diene monomers under the brand name Keltan.

Lanxess also sell chloroprene rubber (CR) under the brand name Baypren; ethylene-vinyl acetate rubber (EVM) under the brand names Levapren, Levamelt and Baymod; hydrogenated nitrile rubber (HNBR) under the brand name Therban, and nitrile butadiene rubber (NBR) under the brand names Perbunan, Krynac and Baymod.

LCY CHEMICAL CORP.

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Website: www.lcy.com.tw

LCY Chemical Corp. is part of LCY Group, a company that operates in the petrochemical, copper material and solar material business. LCY Chemical is one of the world's largest SBC manufacturers. Its products lines including SEBS, SIS, SBS NOE (non-oil-extended) and SBS OE (oil-extended).

LCY Chemical's production facilities are located in Taiwan, mainland China and the U.S. The company has three SBC production lines in its Huizhou, China-based plant. Each line has an annual capacity of 100,000 metric tons.

MICHELIN

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France
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Michelin is the second-largest tire manufacturer in the world. It produces SBR and BR, the two mostly widely used synthetic rubbers for tires. Michelin currently has the capacity of 280,000 metric tons of BR and 130,000 metric tons of SSBR per year.

NANJING JINTENG RUBBER CO. LTD.

Gubai, Gaochun
Nanjing, Jiangsu
China
Tel: 025-57354050, Fax: 025-57354049
Website: en.jintengrubber.com

Founded in 1976, Nanjing Jinteng Rubber is the leading enterprise in the Chinese rubber industry It is a member of China's Rubber Industrial Association, and its production base manufactures the most professional industrial rubber plates in the country. The company has more than 1,100 employees, including 29 senior engineers and technicians. Nanjing Jinteng Rubber has capital of RMB 260 million. By mid-2013, the company's an annual capacity reached 150,000 MT.

NANTONG HUILI RUBBER CO. LTD.

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Haimen, Jiangsu
China
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Specializing in manufacturing and marketing reclaimed rubber and rubber products, Nantong Huili Rubber Co. Ltd. is a state-owned, mid-sized enterprise composed of Nantong Huili Rubber Industry Factory, Haimen Rubber Roller Factory and the Haimen Nanhui Chemical Materials Firm. Established more than 30 years ago, it has capital of RMB 180 million and 800 staff members, and it occupies an area of 84,000 square meters.

In 2010, Nantong Huili Rubber Co. Ltd. had an annual capacity of 80,000 MT of reclaimed rubbers, including 30,000 MT butyl reclaimed rubber, 5,000 MT EPDM (ethylene propylene diene monomer) reclaimed rubber, 4,000 MT color reclaimed rubber, 15,000 MT tire reclaimed rubber, 5,000 MT odorless reclaimed rubber, 5,000 MT rubber and sundry reclaimed rubber, and 5,000 MT tire powder. According to the Reclaimed Rubber Branch of the China Rubber Industry Society, the company's output, output value, marketing, tax and profit ranked first among companies within the industry in China. The capacity grew fast in the last four years and exceeded 150,000 MT by 2013.

NKNH

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Republic of Tatarstan
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ebsite: www.nknh.ru/en

NKNH is one of the largest petrochemical and synthetic rubber producers in Europe. It has an annual capacity of 200,000 metric tons of IR.

SHANDONG DAWN POLYMER CO. LTD.

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China
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E-mail: liu.y@chinadawn.cn
Website: www.dawnprene.com

Shandong Dawn Polymer Co. Ltd. (Dawn) set up a production line with an annual capacity of 3,000 metric tons of TPV in 2008. Dawn currently has two lines with a total capacity of 15,000 metric tons per year.

SIBUR

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Sibur is a Russian petrochemicals company headquartered in Moscow. It has four divisions for producing synthetic rubbers and TPEs.

Voronezhsintezkauchuk is one of the largest manufacturers of rubbers, latex and thermoplastic elastomer in Russia. It is one of Russia's largest producers of polybutadiene rubber of solution polymerization, which accounts for nearly 40% of the company's production.

The company's production of SBS has an annual capacity of 35,000 metric tons of SBS. The production of butadiene-styrene rubbers with a capacity of 30,000 metric tons per year is produced under the Green Tyre program.

Togliattikauchuk is one of the largest petrochemical complexes in Russia, located in Togliatti, Samara Region. The company has six production facilities, including copolymer rubbers with a production capacity of 92,800 metric tons per year, butyl rubber with a production capacity of 48,000 metric tons per year and isoprene rubbers with a production capacity of 60,000 metric tons per year*

In February 2012, Sibur and the India-based Reliance Industries Limited formed the jointly owned company Reliance Sibur Elastomers Private Limited, in which Sibur owns a 25.1% stake. This joint venture was established for the development of a butyl rubber production facility in India with a capacity of 120 kilotons per year.

Sibur-Sinopec Rubber Holding Company Limited is a joint venture between Sibur and China Petroleum and Chemical Corp. (Sinopec) developed on the site of the Krasnoyarsk Synthetic Rubber Plant (KZSK) to produce nitrile butadiene rubbers. Sibur owns 74.99% of the JV.

SINOPEC

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Sinopec's subsidiaries have a total of 680,000 metric tons of ESBR. YPC-GPRO (Nanjing) Rubber Co. Ltd. has an annual capacity of 100,000 metric tons of ESBR. Sinopec Yangzi Petrochemical (YPC) owns 60% of the shares.

STYRON LLC

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Website: www.styron.com

Styron's synthetic rubbers include low-cis polybutadiene rubber (Li-BR), high-cis polybutadiene rubber (Ni-BR), cold polymerized emulsion styrene butadiene rubber (ESBR) and solution styrene butadiene rubber (SSBR).

In the fourth quarter of 2013, Styron's synthetic rubber sales declined 18% due to lower prices and decreased butadiene cost, but adjusted earnings before interest, taxes, depreciation and amortization (EBITDA) for the quarter was $18 million higher than the previous year, reaching $42 million. This increase was driven by higher SSBR volume and other factors. This shows Styron may benefit from growing global SSBR demands in the following few years.

Styron set up three production trains in Schkopau, with a total capacity of 160,000 tons after an expansion in 2011. In 2010, Japan Synthetic Rubber reached an agreement with Styron Europe GmbH for the manufacture of 30,000 tons of SSBR per year. JSR held the capacity rights to 50% of one of Styron's three SSBR production trains. In early 2014, Japan Synthetic Rubber terminated the capacity rights agreement and Styron gained full capacity rights to the train.

TEKNOR APEX

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Founded in 1924, Teknor Apex is a manufacturer of vinyl, nylon, bioplastic, thermoplastic elastomers and other chemicals. It has facilities in nine locations in the U.S., as well as one each in China, Singapore, Belgium and the U.K.

Teknor Apex's thermoplastic elastomers include SBC and TPV. Teknor Apex acquired Sarlink TPV (www.sarlink.com) in 2010.

ZEON

Tel:81-3-3216-2332
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ZEON's product lines include synthetic rubbers, synthetic latices and chemicals. Synthetic rubbers include general-purpose rubbers and special rubbers.

General-purpose rubbers include Nipol SBR, Nipol SBR NS Series, Nipol BR and Nipol IR.

Special rubbers include Nipol NBR, Nipol POLYBLEND, Nipol AR, Zetpol (HNBR), Zeoforte ZSC (ZEON Super Composite) and Hydrin (Epichlorohydrin Polymers)

Japanese market and export market take, respectively, half of ZEON’s global sales. In the fiscal year end on March 31, 2014, ZEON’s domestic sales reached 153.4 billion yen, compare to foreign sales of 143.0 billion yen. Despite facing negative factors such as falling prices, ZEON’s sales grew by 18.2% in fiscal year 2013 from the previous fiscal year. Exports grew faster than domestic sales in 2013.

Chapter 11

APPENDIX GLOSSARY

ELASTOMERS: APPLICATIONS AND GLOBAL MARKETS

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CHAPTER 11
APPENDIX GLOSSARY

ABS
Acrylonitrile butadiene styrene

ACM
Acrylic elastomer

ASEAN
Association of Southeast Asian Nations

BR
Polybutadiene rubber

BRIC
Brazil, Russia, India, and China

CAGR
Compound annual growth rate

CAAM
China Association of Automobile Manufacturers

CNITA
China Nonwovens and Industrial Textiles Association

CR
Chloroprene rubber

CSM
Chlorosulfonated polyethylene

DMT
Dimethyl terephthalate

EASL
Elongation at specified load

ECO
Epichlorohydrin rubber

EPDM
Ethylene propylene diene monomer

EPM
Ethylene propylene monomer

EPR
Ethylene propylene rubber

E.U.
European Union

FKM
Fluorocarbon monomer

FVMQ
Fluorosilicone rubber

Greige fabric
A fabric without dipping or dyeing

HMLS
High modulus and low shrinkage

IIR
Isobutylene isoprene rubber

IR
Synthetic polyisoprene rubber

JCFA
Japan Chemical Fibers Association

MEG
Monoethylene glycol

MPR
Melt processable rubber

NBR
Nitrile rubber

NR
Natural rubber

OE
Original equipment

PA
Polyamide

PE
Polyethene

PEN
Polyethylene naphthalate

PET
Polyethylene terephthalate

POM
Polyoxymethylene

PP
Polypropylene

PPE
Polypheylene ether

PS
Polystyrene

PTA
Purified terephthalic acid

PVC
Polyvinyl chloride polymer

R&D
Research and development

RT
Replacement

SBC
Styrene block copolymer

SBR
Styrene-butadiene rubber

SBS
Styrene butadiene styrene

SEBS
Styrene ethylene butylene styrene

SEPS
Styrene ethylene propylene styrene

SIR
Silicone rubber

SIS
Styrene isoprene styrene

SR
Synthetic rubber

TPA
Thermoplastic polyamide

TPE
Thermoplastic elastomer

TPEE
Thermoplastic polyester elastomer

TPO
Thermoplastic polyolefin

TPS
Thermoplastic styrenic

TPU
Thermoplastic polyurethane

TPV
Thermoplastic vulcanizate

TPVC
PVC-based thermoplastic elastomer

TSE
Thermoset elastomer

